No. 6

TEST SPECIFICATION #7115

FOR

SWITCHYARD IMPACT TESTS (RPI-AAR PHASE 15)

Dated:

September 19, 1975

Revised:

November 4, 1975

APPROVAL:

Jack B. Stauffer, Director
Transportation Test Center

Don Levine
Rail Vehicle Safety Research Division
Federal Railroad Administration

CONCURRENCE:

W. G. Gjertson, Project Manager
Kentron Hawaii, Ltd.
Transportation Test Center

Ross T. Gill
Rail Operations Test Controller
Transportation Test Center

Larry J. Schlink
RPI/AAR

P. Tong
Transportation Systems Center

David Peters
Washington University

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TRANSPORTATION TEST CENTER

COMMONLY USED ACRONYMS

AAR	Association of American Railroads
COTR	Contracting Officer's Technical Representative
CP	Check Pilot
CSB	Center Services Building
CTE	Chief Test Engineer
DOT	Department of Transportation
FRA	Federal Railroad Administration
HA	Hazard Area
HEO	Hazards Evaluation Officer
MOU	Memo-of-Understanding
OCC	Operations Control Center
O&M	Operations and Maintenance
OTP	Operation Test Procedure
PM	Program Manager
PMB	Project Management Building
PSO	Power Station Operator
RDL	Rail Dynamics Laboratory
RPI	Railway Progress Institute
RTTT	Rapid Transit Test Track
SMB	Storage & Maintenance Building
SO	Safety Officer
SOA	Sponsoring Operating Administration
SOP	Standard Operating Procedures
TC	Test Controller

COMMONLY USED ACRONYMS (Continued)

TDT	Train Dynamics Track
TMB	Transit Maintenance Building
TSO	Track Security Officer
TSC	Transportation Systems Center
TSE	Test Support Engineer
TTC	Transportation Test Center
UMTA	Urban Mass Transportation Administration
VO	Vehicle Operator

1.0 GENERAL

1.1 INTRODUCTION

1.2 TEST OBJECTIVES

1.3 REFERENCE DOCUMENTS

1.4 PROGRAM PARTICIPANTS AND RESPONSIBILITIES

TEST SPECIFICATION

SWITCHYARD IMPACT TESTS

1.0 GENERAL

1.1 INTRODUCTION

A research project began at Washington University, St. Louis, Missouri on March 1, 1974 with the principle objective to develop a rational basis for designing devices suitable for the protection of hazardous material tank cars from head puncture in switchyard impact and on line derailment situations. The first goal of this project was to acquire an understanding of head puncture mechanisms and, through this understanding, to estimate the direction and magnitude of coupler forces (as time functions) in critical situations. Studies of accident reports lead to the conclusion that puncture mechanisms involve excessive pitching, motion of cars excited by longitudinal coupler forces. A mathematical model, capable of simulating such pitching motion, has been developed. Following a series of test runs, three actual accidents, known as the East St. Louis, Decatur and Houston accidents, were simulated. On the basis of this simulation, it was concluded the sequence of events in the East St. Louis accident was different from the previously assumed events. This underlines the importance of quantitative studies of each accident occurrences.

The quantitative approach requires that the dynamic parameters of train consists be known with reasonable accuracy. Some of the parameters can be measured readily, others, such as the response of draft gears and ladings to forces applied in rapid succession, require additional experimental and theoretical work. Simulation of the East St. Louis, Decatur and Houston accidents was based on best available estimate of the parameters. In order to verify the model a series of impact tests are to be conducted under controlled conditions.

1.2 TEST OBJECTIVES

The series of impacts will consist of two parts; tests and analysis. The analytical part will be accomplished by Washington University. RPI/AAR will provide inputs as mutually deemed appropriate.

The major portion of the program will be conducted at the Transportation Test Center (TTC), Pueblo, Colorado. This portion will be a series of impact tests involving the striking of an empty hopper car with Class 112A or 114A tank cars loaded with water to simulate LPG. A maximum of eleven seires of tests will be conducted. Some may be eliminated, depending on results from others. In most of these eleven series, impacts will be at increasing increments of speed until either a puncture occurs or the damage is destructive.

All data will be reduced and used to study the specific problem of head punctures occasioned by on-track impacts of loaded tank cars into an empty hopper car and to determine the probable effectiveness of the shelf coupler, the head shield, or both in combination, toward preventing punctures. The influence of the number of impacting cars and cars backing up the impacted car will also be studied.

1.3 REFERENCE DOCUMENTS

The following reference documents were used to compile this Test Specification for performance of this test program:

a. Switchyard Impact Tests - Full Scale by RPI/AAR, July 18, 1975.

b. Test Plan for Switchyard Impact Tests (RPI/AAR Phase 15) May 20, 1975 (TTC Document).

c. Full Scale Controlled Velocity Switchyard Impact Tests. Test and Instrumentation Specification August 6, 1975 (Washington University Document).

d. Minutes of Meeting on Full Scale Switchyard Impact Tests, TTC August 5 and 6, 1975.

1.4 PROGRAM PARTICIPANTS AND RESPONSIBILITIES

1.4.1 The following personnel will be participating in this test project:

RPI/AAR (Railroad Tank Car Safety Research and Test Project

Earl Phillips

Larry Schlink

John Everett

E. J. Kunz

L. L. Olson

FRA-Washington:

L. Peterson, RRD-30

D. Levine, RRD-33

D. Dancer, RRD-33

TTC-FRA-Pueblo:

J. Stauffer

H. Smith

R. Gill

TTC-O&M:

Keith Kieres

J. Johnson

Transportation Systems Center:

Pin Tong

Washington University:

B. Szabo

W. Diboll

D. Peters

1.4.2 Organizational Responsibilities:

Responsibilities	Organization	Individual
Overall test planning, management and fueling	FRA/RPI/AAR	D. Levine, FRA L. Schlink, RPI/AAR
Technical support and design of experiments	Washington U.	D. Peters
Technical Advisor to FRA	TSC	P. Tong
Conduct of tests	TTC	R. Gill

1.4.2 Continued

a. Don Levine will be FRA Test Director for the Phase 15 Switchyard Impact Tests and will serve as point of contact between the SOA (FRA) and the TTC Test Controller. David Dancer, FRA, will serve as his alternate. In addition, Mr. Levine, or his alternate will be responsible for insuring that DOT/FRA and RPI/AAR objectives and goals for the conduct of these tests are indeed fulfilled.

b. L. J. Schlink will be the RPI/AAR Phase leader, and it will be his responsibility to insure that the RPI/AAR commitments to this program are fulfilled in an orderly manner, test data suitable to the RPI/AAR is obtained, and any conflict regarding the conduction of the test and changes in the test program are resolved to the mutual satisfaction of the RPI/AAR and the DOT. J. E. Everett, E. L. Kunz, and/or L. L. Olson will serve as alternates.

c. David Peters, representing Washington University, will provide technical support and planning for the tests. He will be responsible for insuring that the design of the tests and the acquisition and analysis of the data are performed in such a manner that the test results provide accurate and relevant information for improving tank car safety.

d. Ross Gill, Rail Operations Test Controller, will be the Transportation Test Center Test Controller (TC) and will be the TTC interface on these tests for all program participants.

e. Harry Smith, TTC Hazards Evaluation Officer, will ensure that the TTC Safety Policies and Procedures are complied with.

f. Keith Kieres, Kentron Hawaii, Ltd. (KHL), will act as Chief Test Engineer (CTE). The Test Project Manager will be named at a later date.

g. Ron Begier, Kentron Hawaii, Ltd., will be the TTC Test Support Engineer (TSE).

1.4.3 Pre-test Acceptance

In order to provide complete agreement by all parties prior to the conduct of tests representatives of the cognizant organizations will be at TTC 24 hours prior to the commencement of a test series (preliminary tests also) for final inspection of equipment and instrumentation set up. The TTC will notify all parties 7 days in advance of such tests as best can be projected. Should personnel from participating parties not be available, notification in writing or telephone must be conveyed to TTC. The following groups should be represented:

RPI/AAR	-	Any Phase 15 team member.
FRA	-	Representatives from OR&D Office of Rail Safety Research.
TTC	-	Test team as required for conduct of tests.
Washington University	-	D. Peters, of Washington University

1.4.4 Distribution List

All modification or changes to this Specification will be distributed by TTC to the following personnel:

Mr. Dave Dancer
Federal Railroad Administration
Rail Vehicle Safety Research Div., RRD-33
2100 2nd Street, S.W.
Washington, D.C. 20590 — 7 copies

Mr. Pin Tong
Transportation Systems Center
Mail Code 612
Kendall Square
Cambridge, MA 02142 — 2 copies

Dr. W. J. Harris, Jr.
Vice President
Research and Test Department
Association of American Railroads
American Railroads Building
1920 L Street, N.W.
Washington, D.C. 20036 — 1 copy

Mr. Ross T. Gill
Rail Operations Test Controller
Transportation Test Center
Pueblo, Colorado 81001 — 10 copies

Mr. John E. Everett
Design & Development Engineer
Tank Car Division
General American Transportation Co.
P.O. Box 532
Sharon, Pennsylvania 16146 — 2 copies

Mr. Larry J. Schlink
Product Engineer
Union Tank Car Company
151st & Railroad Avenue
East Chicago, Indiana 46312 — 1 copy

Mr. E. L. Kunz
Product Engineer - Tank Cars
ACF Industries, Incorporated
Amcar Division
Clark and Main Streets
St. Charles,MO. 63301
(Copies for S. Holcumb and C. Reedy) — 3 copies

Mr. L. L. Olson
Association of American Railroads
3140 S. Federal
Chicago, Illinois 60618 — 1 copy

Dr. Barna A. Szabo
School of Engineering and Applied Science
Washington University
St. Louis, Missouri 63130
(Copies for W. B. Diboll and
D. Peters) — 3 copies

Dr. Michael T. Wilkinson
Department of Mechanical Engineering
Louisiana Tech University
Ruston, Louisiana 71270 — 1 copy

Mr. Earl A. Phillips
AAR Technical Center
3140 South Federal Street
Chicago, Illinois 60616 — 1 copy

1.4.5 Major Responsibility Outline

DOT-TTC

a. The Test Site

b. Pre-Test Measurements

c. Test Instrumentation and all Photo Coverage.

d. Conduction of Test

e. Repairing Test Site between and after all tests.

f. Tank car and back-up car lading.

g. Furnish 3 loaded back cars and their disposal.

h. Filling, emptying and transferring Tank Car Lading.

i. Transportation of all cars from North Avondale into the Test Center.

j. Return of tank cars to North Avondale in suitable condition for rail transportation to repair shops.

k. Suitable locomotive for conducting tests.

l. Suitable equipment for handling and removing damaged cars.

m. Disposal of tank car lading.

n. Provisions for pressurizing tank cars.

o. Recording and reduction of Test Data.

p. Means for assuring coupler impacts head in Test Series No. 8.

q. Arrangements for scraping cars.

RPI/AAR

a. Provide 28 Tank Cars.

b. Preparation of the 28 Tank Cars (re-spring trucks, apply shelf couplers and head shields).

c. Procurements and disposal of empty hopper cars which will be impacted.

d. Movement of tank and hopper cars to Avondale.

e. Movement of tank cars from Avondale to repair shops.

f. Two Technician/Engineers for duration of testing.

g. Periodic Fatigue Inspection of tank cars used in testing.

1.4.6 Checklist - Phase 15

ITEM	RESPONSIBILITY	DATE	REMARKS
1. Overall Test Coordinator	D. Dancer (LJS)		
2. Prepare Test Program	LJS (DMD)		
3. Prepare Test Schedule	LJS (DMD)		
4. Instrumentation Plan & Sketch	FRA		
5. Drawings & Specifications for Tank Cars	LJS JEE		
6. Drawings & Specifications for Hopper Cars	LJS (JEE)		
7. Prepare List of RPI-AAR Mat'ls & Equipment for Test Site	LJS (JEE)		Dynamometer Coupler
8. Ship Materials & Equipment to Test Site	(Later)		
9. Procurement of 28 Hopper Cars	EAP (LJS)		Contract arrangements
10. Advise Transition temperatures	RPI-AAR		
11. Heating Tank Cars Loaded with Water	FRA (RTG)		
12. Inspect Hopper Cars after arrival at No. Avondale	RPI-AAR		See Section 11.
13. Procurement and Disposal of 5 Back-Up Hopper Cars	FRA		
14. Order "E" Shelf Couplers	EAP		
15. Order "F" Shelf Couplers	EAP		
16. Manufacture Head Shields	(later)		
17. Write Procedure for Pressurizing Tank Cars	CER		
18. Provide Appropriate Equipment for Pressurizing Tank Cars	FRA		
19. Velocity Control	LJS		Check FRA Procedure
20. Inspection of 26 Tank Cars Before Release to North Avondale	UTC (LJS) GAT (JEE)		
21. Free Car Movements			

1.4.6 Checklist - Phase 15 (Continued)

ITEM	RESPONSIBILITY	DATE	REMARKS
22. Arrange Shipment of 28 Tank Cars to North Avondale	UTC (LJS) GAT (JEE)		
23. Coordinate Hopper Car Movement to North Avondale with Shipper	LLO (LJS) (JEE)		
24. Personnel Clearances and Visitors Arrangements, All Tests	EAP (DMD)		Notify EAP who will be there and when -contact: R. Gill or K. Grunwald
25. Notify Interested Parties Who Wish to Witness Test(s)	EAP (DMD		T. Chastain; N. Morella; H. L. Scott, Jr. (NW)
26. Movement of Tank and Hopper Cars from North Avondale to Test Site	FRA		
27. Represent RPI-AAR at Test Site	AAR (LLO) ACF (ELK) GAT (JEE) UTC (LJS)		
28. Inspection of 26 Tank Cars After Arrival at Test Site	RPI-AAR		
29. Instrument Cars	FRA		
30. Pre-Test Measurements	FRA		
31. Tank Car Lading	FRA		
32. Furnish and ship - one (1) Dynamometer Coupler (E)	UTC (LJS)		FRA to return to Miner Enterprises
33. Lading for Back-Up Hopper Cars	FRA		Five (5) hopper cars to be loaded at TTC.
34. Fill, Empty, Transfer and/or Dispose of Test Lading	FRA		
35. Locomotive for Test	FRA		
36. Suitable Track	FRA		
37. Equipment for Handling and Removing Damaged Cars	FRA		
38. Velocity Measurements Before and After All Impacts	FRA		
39. Coupler Force(s) All Tests	FRA		

1.4.6 Checklist - Phase 15 (Continued)

ITEM	RESPONSIBILITY	DATE	REMARKS
40. Conduct Test	FRA		
41. Movies of All Tests	FRA		
42. Repair Test Site	FRA		
43. Design Means for Discontinuity Tear	RPI-AAR (FRA)		Contingency Test
44. Provide Means for Discontinuity Tear	FRA		Contingency Test
45. Record & Reduce Test Data	FRA		
46. Post Test Inspection			
47. Procurement of Parts Required to Return Tank Cars	FRA (RPI-AAR)		Includes gondolas or flat cars as may be necessary
48. Cost of Parts Required to Return Tank Cars	FRA		Includes gondolas or flat cars as may be necessary
49. Cut Stencil for Tank Cars "Home for Repairs. Do Not Load Until Repaired."	RPI-AAR		Rule 95 B.g. (3)
50. Stencil Tank Cars "Home for Repairs. Do Not Load Until Repaired."	FRA		Rule 95 B.g.(3)
51. Shipment of Tank Cars from Test Site to North Avondale	FRA		
52. Shipment of Tank Cars from North Avondale to Repair Shops	GAT (JEE) UTC (LJS)		
53. Preparation and Movement of Hopper Cars for Disposal After Test	FRA		
54. Disposal of Hopper Cars After Test	RPI-AAR		Proceeds of sale to AAR.
55. Write Test Report	RPI-AAR, FRA		Individual Reports
56. 2 - 20,000 gal. 111-A Cars with Bottom Outlets	RPI-AAR		Additional Impacting Cars.
57. Mechanical Trip Valve	FRA		May be Used When No Back-Up Hopper Cars Involved.

2.0 TEST REQUIREMENTS

2.0 TEST REQUIREMENTS

Conditions common to all tests are:

2.1 All struck and striking cars to be resprung and rebuilt to mechanical and structural condition as necessary for test purposes.

2.2 Struck Cars:

a. Cars to be 50-ton steel open top hopper cars.

b. Cars to have a light weight not greater than 44,000 pounds.

c. Car truck centers to be approximately 30 feet.

d. Cars to be equipped with conventional draft gear and standard E couplers.

e. Couplers will be extended on butt end to normal operating length, in accordance with AAR "Manual of Standards and Recommended Practices" Spec. M-204A-68 Fig. 8, so the draft gear will bottom prior to the horn hitting the striker plate.

f. All cars to be of the same type for all tests.

2.3 Striking Cars:

a. Cars to be nominal 33,000 gallon class DOT 112A or DOT 114A tank cars. Where three striking tank cars are required, only the lead car must conform to 2.3 requirements.

b. The diameter and thickness to be the same for all cars.

c. The same type or same AAR rated draft gear in each car is preferred.

d. Cars to be generally identical for all tests.

e. Cars to be equipped with grade "C" couplers.

2.4 Test Conditions

a. Strking couplers to be "in-line" laterally, knuckles to be opened by decoupling from struck cars. Insure coupler pin is free to fall on impact.

b. The internal pressure in the striking tank car(s) for test series, all tests, to be 100 psig.

c. The striking car(s) to be loaded with water to a volume established by preliminary tests.

d. Water in striking car to be such that the head temperature on the outside of the car will be at least 60° F. immediately before impact for test series 1 thru 11.

T E S T   M A T R I X

Refer to Operational Sequence Diagram, Figure B-2, Blocks 27, 28, and 29.

Series	Impacting Cars	Back Up Cars	Head Shields	Type Coupler Tank Car	R E M A R K S
Preliminary Tests	1	0	NO	E	Effects of surging, liquid lading 62.7, 75 and 94.6% full, 4, 6 & 8 mph impacts. Braking of cars to occur after data acquisition. 100 psi in tank. Coupler lever to be tied to prevent coupling.
1	1	0	NO	E (Std)	(Uncoupling effect) Impact at 4 mph and increase in 2 mph increments to destructive damage. Duplicate velocities up to uncoupling velocity.
2	1	3	NO	E (Std)	Starting at speed at which no coupling occurs, repeat with backup cars placed in positions determined from series #1, to include maximum coupler elevation on 3rd impact, (override).
3	1	3	YES	E (Std)	Effectiveness of Head Shield (if shields available at this time)
4	1	3	NO	F (Std)	Effectiveness of F Standard Coupler
5	1	3	NO	E Shelf	Effectiveness of E Shelf Coupler
6	1	3	NO	F Top Shelf	Effectiveness of F Top Shelf (DOT Request)
7	1	3	YES	E (Std)	Contingency Test
8	1	3	YES	E Shelf	Effectiveness of Shield and E Shelf Coupler Combination
9	3	3	YES	E (Std)	Effect of Impacting Car Consist
10	3	3	NO	E (Std)	Effect of Impacting Car Consist
11	1	0	NO	E (Std)	Cut lever on and off. Knuckles open and closed. Four mph in 2 mph increments to 10 mph maximum or failure to couple.

Figure A-1

PRE-TEST MEASUREMENT SCHEDULE

PRE-TEST MEASUREMENT	TANK CAR #1	TANK CAR #2	HOPPER CAR #1	HOPPER CAR #2	HOPPER CAR #3
Delivery to TTC	29 July 1975	10 Sept 1975	25 Aug 1975	25 Aug 1975	25 Aug 1975
Total Weight Truck Weight	27 Aug 1975	2 Sept 1975	2 Sept 1975	2 Sept 1975	2 Sept 1975
Length Between Coupler Faces Length Between Truck Centers Vertical Play at Sill Vertical Play at Coupler Coupler Height Above Rail	8-10 Sept 1975	8-10 Sept 1975	8-10 Sept 1975	8-10 Sept 1975	8-10 Sept 1975
Travel of Truck Center Plate and Pins to Release Vertical Spring Rates and Deflection Curves	29 Sept-3 Oct	NR	6-10 Oct 1975	NR	NR
Force Deflection Plot during and after Bottoming of Truck Springs to 400 kips	22-26 Sept 1975	NR	29 Sept-3 Oct	NR	NR
Locate Center of Gravity Determine Moment of Inertia	NR	NR	17-19 Sept 1975	NR	NR
Frequency and Damping of Car on Trucks	NR	NR	13-15 Oct 1975	NR	NR
Travel of Truck Bolsters to Spring Bottom and Up to Hitting Side Frame	22-26 Sept 1975	NR	29 Sept-3 Oct	NR	NR
Car to Car Impacts	16-17 Oct 1975	16-17 Oct 1975	14-15 Oct 1975	14-15 Oct 1975	NR

Figure A-2

FULL SCALE CONTROLLED VELOCITY SWITCHYARD IMPACTS TEST SCHEDULE

PRELIMINARY TESTS: 20 - 31 October 1975
DATA REDUCTION: 3 - 14 November 1975

TEST SERIES & DATA REDUCTION (two weeks each)

TEST SERIES 1:	17 November - 12 December 1975
TEST SERIES 2:	15 December - 16 January 1976
TEST SERIES 3:	19 January - 13 February 1976
TEST SERIES 4:	16 February - 12 March 1976
TEST SERIES 5:	15 March - 9 April 1976
TEST SERIES 6:	12 April - 7 May 1976
TEST SERIES 7:	10 May - 4 June 1976
TEST SERIES 8:	7 June - 2 July 1976
TEST SERIES 9:	6 July - 30 July 1976
TEST SERIES 10:	2 August - 27 August 1976
TEST SERIES 11:	30 August - 17 September 1976

DRAFT REPORT: 20 September - 10 October 1976

NOTE: Required cars furnished by RPI/AAR to be on site one week prior to start dates shown for each test.

Figure B-1

OPERATIONAL SEQUENCE DIAGRAM

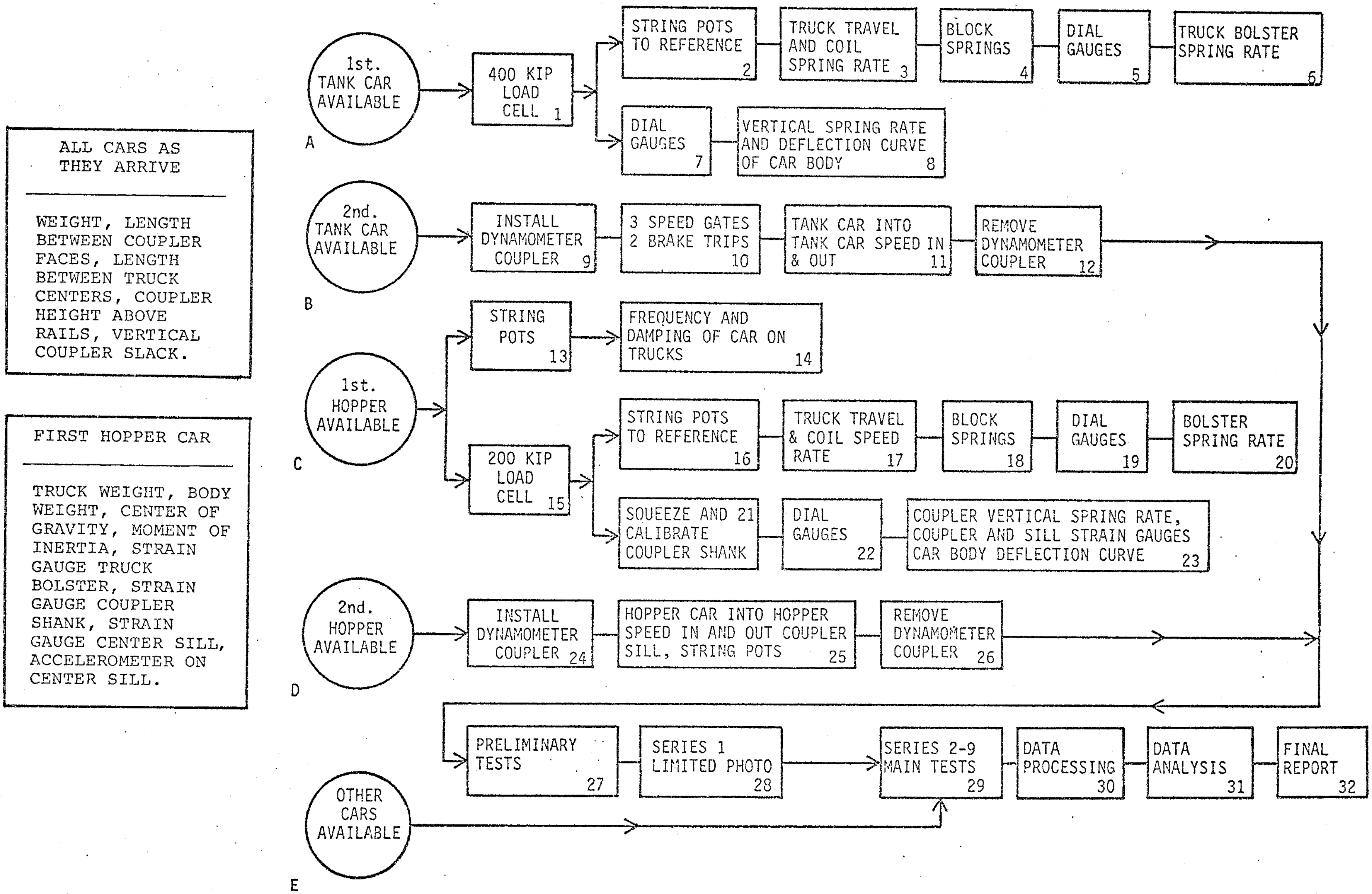


Figure B-2

3.0 PHOTO COVERAGE REQUIREMENTS

3.1 PRELIMINARY TESTS

3.2 TEST SERIES 1

3.3 TEST SERIES 2 THROUGH 9

3.0 PHOTOGRAPHIC INSTRUMENTATION TEST COVERAGE

3.1 PRELIMINARY TESTS

Preliminary test will be covered by still photographs to document the pertinent facts for this test. Two cameras, 1 - 500 FPS and 1 - Real Time, will be placed to monitor sloshing effect; 90° to impact, to cover tank car and hopper car for a minimum of 25 feet after impact.

3.2 TEST SERIES 1

a. Four high speed movie cameras (500 FPS) to be placed as shown in Figure C-1.

b. Two CCTV cameras to be used to monitor and record data for instant replay as shown in Figure C-1.

c. Each pair of tests at a common impact speed will be photographed on the same roll of film where possible.

d. Color negatives will be taken for color prints, and 35mm color slides will be taken to document pre-test work, camera and other instrumentation device locations.

3.3 TEST SERIES 2 THROUGH 9

a. Test series 2 through 9 will have full camera and CCTV coverage as shown in Figure C-1.

b. Final camera positions will be determined by inspection of the test vehicles on sight.

c. Light colored paint and possible use of auxiliary lights will be used to enhance the photography for close-in coupler height impacts.

CAMERA L[illegible]ATION MATRIX

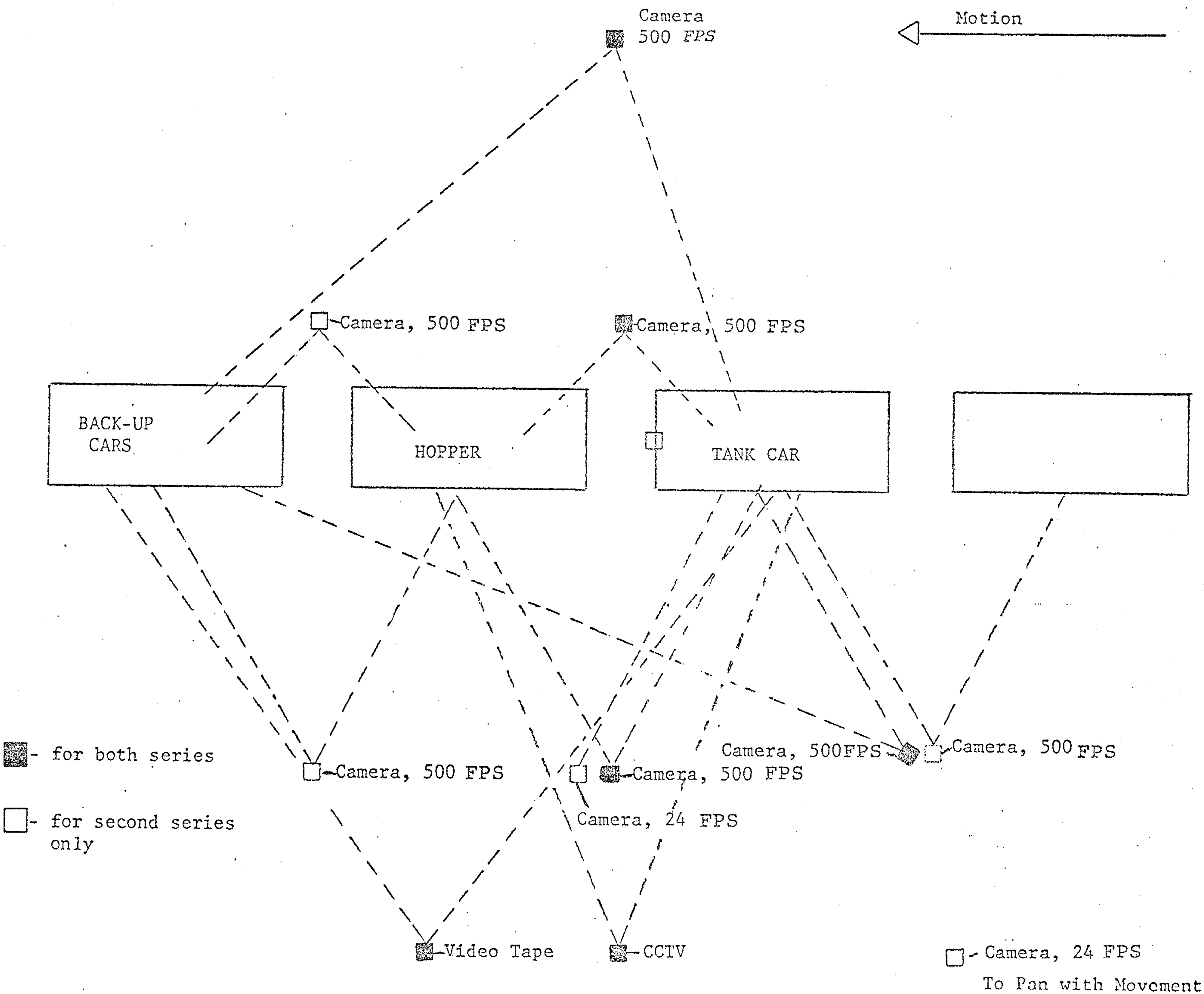


Figure C-1

4.0 INSTRUMENTATION REQUIREMENTS

4.0 INSTRUMENTATION REQUIREMENTS

4.1 Impact end of hopper car to have dynamometer coupler for preliminary tests and a strain gauged coupler for the main series of tests. Coupler strain gauges to be recessed to prevent destruction. Coupler travel will be adjusted to normal condition to ensure that draft gear bottoming occurs before the horn hits the striker plate.

4.2 Hopper car center sill to be strain gauged at impact end. Strain gauges must be located behind draft lugs but in front of truck bolster pin. Six gauges are required, two to measure strain on upper surface of sill, two to measure strain on lower flanges, and two to measure strain on neutral axis.

4.3 One accelerometer to be mounted on impact end of hopper center sill and near strain gauge locations to determine the initial shock spectrum of impacts.

4.4 A string pot will be used to measure longitudinal displacement of hopper car coupler at impact end.

4.5 String pot type displacement gauges will be used to measure vertical and pitching motions of the hopper car with respect to the side frames.

4.6 Two strain gauges to measure truck bolster bending on impact end of hopper car.

4.7 Dial gauges and calibrated load cells to be used for pretest deflection measurements.

4.8 Impact velocity will be accurately controlled and velocities of cars before and after impact will be measured by speed gates.

4.9 A list of instrumentation types, locations, and channels are given in Appendix A.

5.0 PRE-TEST MEASUREMENT REQUIREMENTS

5.1 FORCE CALIBRATION

5.2 PRELIMINARY TEST/EFFECT OF SLOSHING

5.3 INSPECTION REQUIREMENT FOR ALL RPI/AAR FURNISHED HOPPOR CARS

5.0 PRE-TEST MEASUREMENT REQUIREMENTS

a. Total weight (all cars).

b. Truck weight and body weight (tank and hopper cars).

c. Lading weight (tank cars).

d. Length between coupler faces (all cars).

e. Length between truck centers (all cars).

f. Maximum possible travel of truck center plate and pins to release (one hopper car).

g. Vertical play of coupler at end sill and at coupler knuckle (all cars) with all coupler and draft gear slack removed in buff.

h. Coupler heights above rails (all cars) - coupler heights must be within AAR limits. For all impact testing between empty car and loaded car vertical coupler offsets must be identical ± 1/2".

i. Maximum possible travel of truck bolsters down to spring bottom and up to hitting side frame (one hopper and one tank car).

j. Experimentally locate center of gravity by three point suspension (one hopper car).

k. Determine moment of inertia about center of gravity by swinging car in pendulum fashion and measuring frequency (one hopper car).

l. Items j. and k. to be calculated for loaded tank car.

5.1 FORCE CALIBRATION

5.1.1 Measure force deflection plot of one truck on one hopper car and one tank car during and after bottoming of truck springs, as outlined in Appendix B. Truck strain gauges on hopper car to be calibrated at this time.

5.1.2 Measure vertical spring rates and deflection curves for one hopper car and one loaded tank car by lifting on coupler as outlined in Appendix C. Hopper car strain gauges in coupler shank and sill to be calibrated for bending at this time. (Distance to clear hopper car center pin may also be determined.)

5.1.3 Impact two identical tank cars and also two identical hopper cars as outlined in Appendix D. These tests will be used to calibrate longitudinal sill strain gauges using dynamometer couplers. The tests will also provide longitudinal spring rates.

5.1.4 Calibrate longitudinal force coupler shank strain gauges by appropriate squeeze test of coupler shank.

5.2 PRELIMINARY TEST/EFFECT OF SLOSHING

In order to determine the effect of sloshing in the impact tests, a tank car will be impacted into the hopper car under the conditions of:

a. Tank car 62.5% full of water.

b. Tank car 75% full of water.

c. Tank car 94.6% full of water.

The impacts will be at 4, 6, and 8 mph and speed gate and low speed movie coverage used. The films and force data will be used to determine the effect of sloshing. Cut levers will be tied up to prevent coupling and full hopper car instrumentation will be used.

5.3 INSPECTION REQUIREMENT FOR ALL RPI/AAR FURNISHED HOPPER CARS

Inspect for compliance with the following:

I. Couplers

a. The operating mechanism used with the Articulated Rotary Coupler is generally of the one-piece standard design as shown in Figure 5-1.

The alternate standard rod is similar to the standard in design except that it is provided with with a turned-in hand grip at the extreme end of the handle.

It is important to have at least 1/4 inch and preferably not more than 1/2 inch clearance between the operating rod eye and the locklift lever (Dimension A) when the coupler is centered in the carrier and the coupler fully locked.

The portion of the rod next to the handle, as viewed from the front (Dimension C), must be parallel to the end sill to insure contact of the handle with the bracket stop surface when the coupler moves laterally toward the bracket.

The clearance B between the bracket and rod handle must be not less than 3-3/4 inches nor more than 4-1/4 inches, and the straight portion of the rod must extend at least 4-1/4 inches beyond the bracket eye.

b. The coupler operating mechanism should open the knuckle when the handle is raised to the top position.

c. The lock must drop freely to the locked position when the knuckle is closed slowly. The lock is in the locked position when it rests on the shelf of the knuckle tail.

d. Determine the effectiveness of the anti-creep protection. Insert a bar between the lock and knuckle tail shelf and pry the lock upward and at the same time force the lock leg rearward by inserting a screwdriver between the lock leg and the front of the lock hole as shown in Figure 5-2.

   If the lock can be raised by this method enough to permit opening of the knuckle, the coupler has insufficient anti-creep protection. Correction of insufficient anti-creep protection should be made by replacing (1) the locklift assembly, (2) the lock, or (3) the knuckle. Usually replacement of the locklift assembly is sufficient but in some cases further benefit is obtained by renewal of the lock and/or knuckle.

e. If the distance between point of knuckle and guard arm exceed 5-5/16 inches as measured by the gage shown in Figure 5-3, the defective part or parts must be renewed to bring the coupler within required gage of 5-1/8 inches as measured by the gage shown in Figure 5-4.

f. Type "E" knuckles must be renewed when Gage No. 44057 can be passed vertically over the knuckle nose as shown in Figure 5-5.

g. Wear plate must not be worn more than 1/8" deep. If the coupler is not equipped with a wear plate, the shank must not be worn more than 1/4" deep.

h. When coupler is removed from car for any reason, inspect coupler shank length and rear of keyslot to shank butt length. Coupler must meet the following requirements:

   Minimum shank length as shown in Figure 5-6 per dimension A is 21".

   Minimum length for average dimension per dimensions B and C shown in Figure 5-6 is 3-3/4".

i. The maximum permissible free slack in the draft attachment is one inch. The amount of free slack can be determined by first sledging the coupler back solid and then measuring the clearance between the coupler horn and the striker face. Next, by inserting a long bar between the horn and striker face, pry the coupler out as far as possible and again measure the space between the horn and striker. The difference between these two measurements is the amount of free slack present.

   Excessive free slack (normally more than 1") indicates a part may be missing, broken or excessively worn and requires a closer inspection and/or disassembly.

II. Yokes

Yoke must not be missing, bent, broken, cracked, etc., except for cracks through web portion from rear of key slot, one or both sides. See Figure 5-7.

III. Draft Gears

a. Draft gears must not be missing or defective. Draft gears will be considered defective when any part of same, except external retaining bolt or rod only, is defective. When draft gear is removed in conjunction with other work, defective retaining bolts or rods should be renewed.

b. Follower plate must not be missing or broken.

c. Support plate and fasteners must not be defective.

IV. Car Body

Coupler carriers, center plates, center sills, center pins and rear draft lugs must not be defective.

V. Truck Spring Assemblies

Spring Assemblies (including friction snubbers) must not be missing or defective. (Note: Cars are to be resprung prior to shipment to the Transportation Test Center).

Deviations from the above requirements are to be expected and must be handled on an individual car basis. Please note any deviations and contact the RPI-AAR representative for disposition.

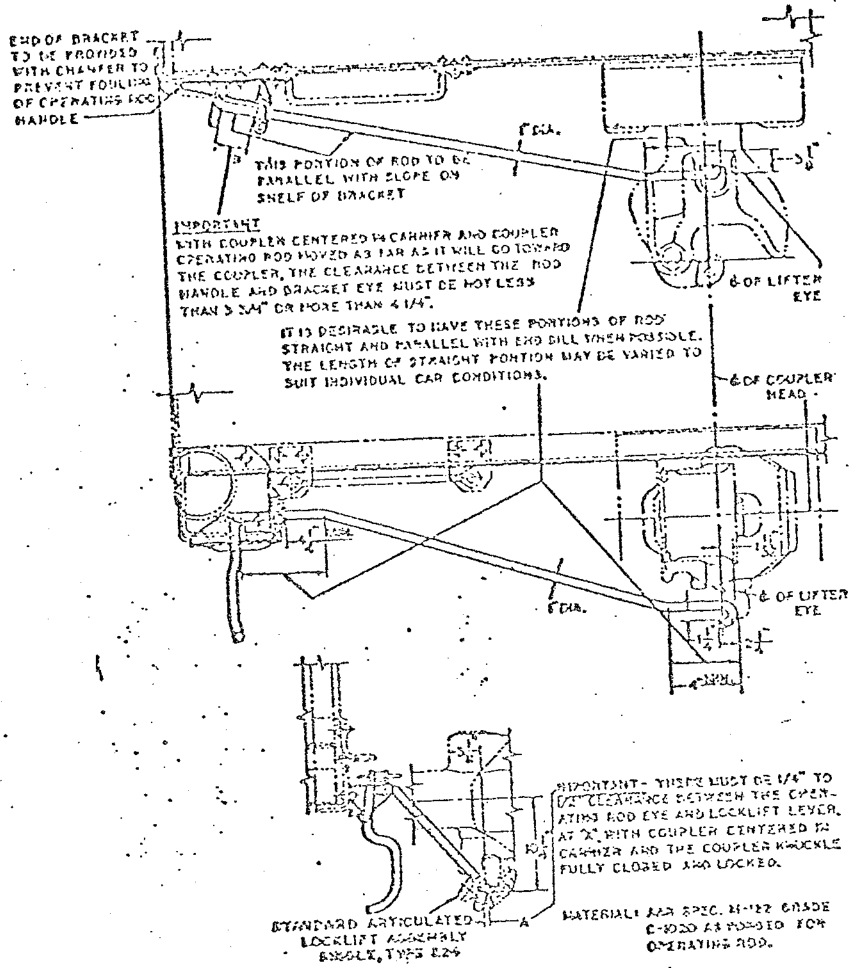


FIGURE 5-1

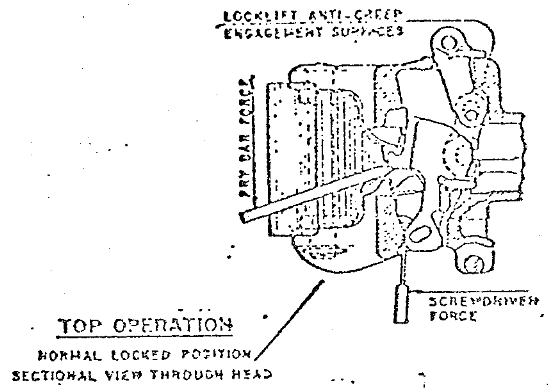


FIGURE 5-2

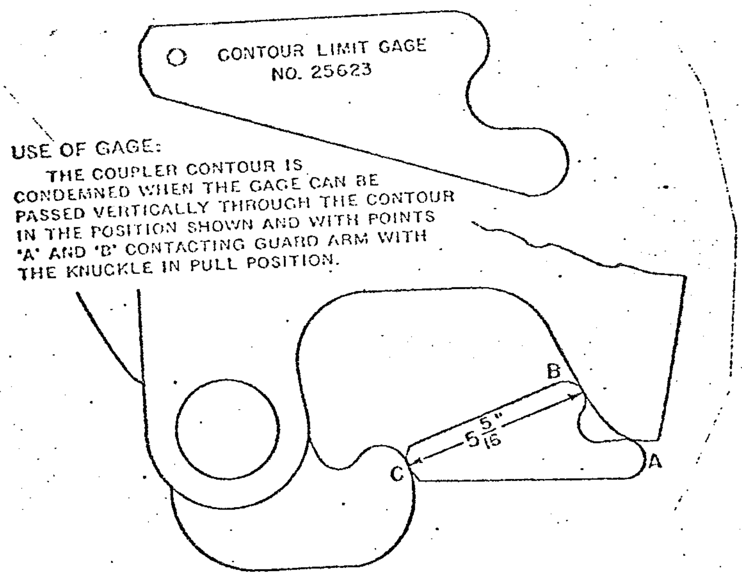


FIGURE 5-3

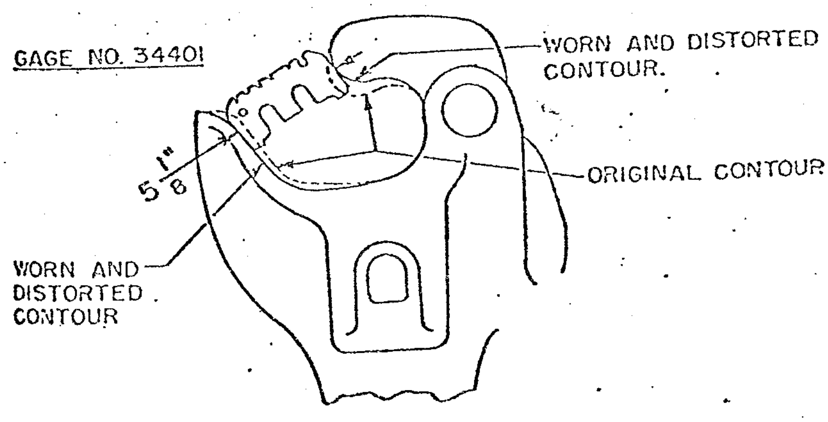


FIGURE 5-4

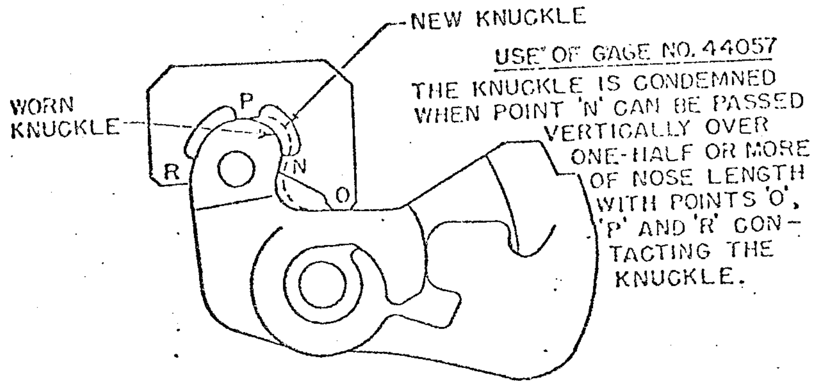
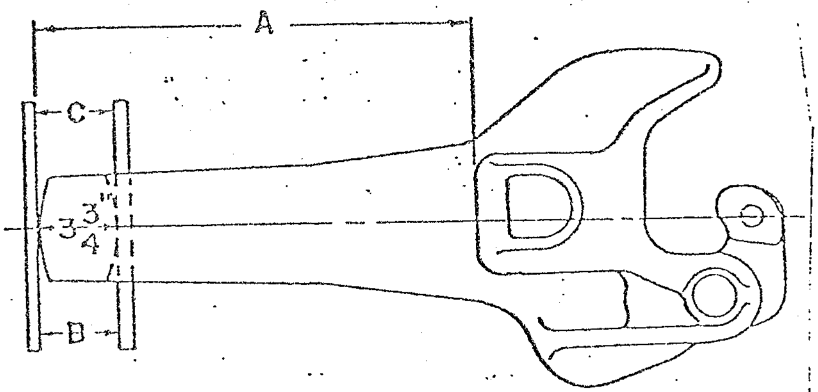


FIGURE 5-5



TO DETERMINE DISTANCE FROM KEY SLOT TO BUTT, ADD DIMENSIONS "C" AND "B" THEN DIVIDE BY TWO (2).

FIGURE 5-6

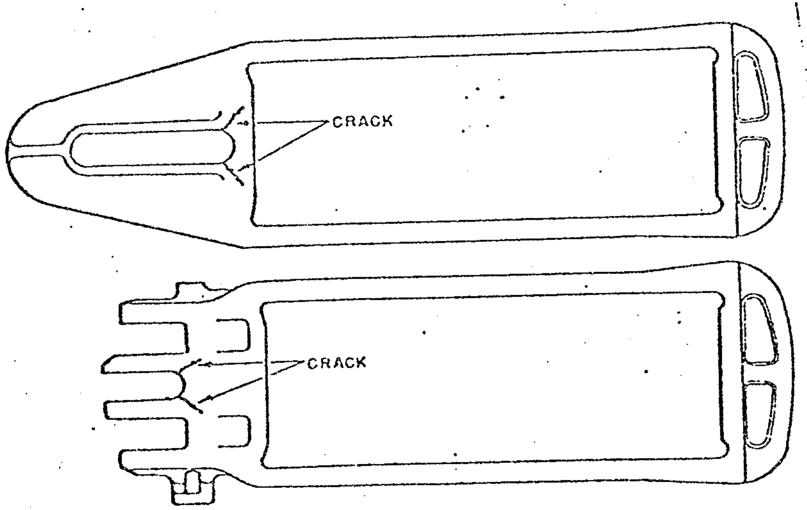


FIGURE 5-7

6.0 DATA RECORDING / REDUCTION REQUIREMENTS

6.0 DATA RECORDING/REDUCTION REQUIREMENTS

a. All measured data channels will be stored on analog tape with strip chart back-up.

b. Data will be analyzed as outlined in Appendix E and provided in digital and graphical form.

c. Graphs will be plotted individually and scaled according to Washington University Specifications.

6.1 DATA RECORDING/REDUCTION TECHNIQUES

a. Twenty channels of data and time will be recorded.

b. All data will be filtered to remove frequencies above 100 Hz.

c. All data will be sampled at 500 samples/second.

d. Approximately .8 seconds of data following impact is required. (Subsequent tests may have as many as three [3] impacts, .8 seconds of data after each is required.)

e. The data will be recorded in real-time by hard copy on 0-graph.

f. Displays will be in the form of graphs plotted at .1 sec/in. on the X-axis and appropriate scaling on the Y-axis.

6.2 HARDWARE CONFIGURATION

The hardware which will be used to satisfy the requirements is detailed in the following list.

a. Varian 620/f minicomputer and associated peripherals.

b. Datawest Analog to Digital (A/D) hybrid system.

c. 100 Hz 6 Pole Butterworth Filters (analog).

d. Metraplex 120 FM demodulators.

e. Bell and Howell CPR4010 portable record/playback unit.

f. DATUM Model 9200 Time Code Reader.

g. DATUM Model 9100 Time Code Generator.

Figure D-1 shows a block diagram for configuration of the above mentioned hardware.

6.3 SOFTWARE CONFIGURATION

A set of computer programs have been designed to control the acquisition and recording of data, and compute with required data, output values for printing and plotting. All modules are written in Varian FORTRAN IV with the exception of those routines necessary to interface with the hybrid equipment. The MOS operating system will be used to control the loading of program modules. The following four (4) paragraphs delineate the functional characteristics of the software modules necessary for data reduction. Figures D-2 and D-3 show graphically the module interdependence, input and output.

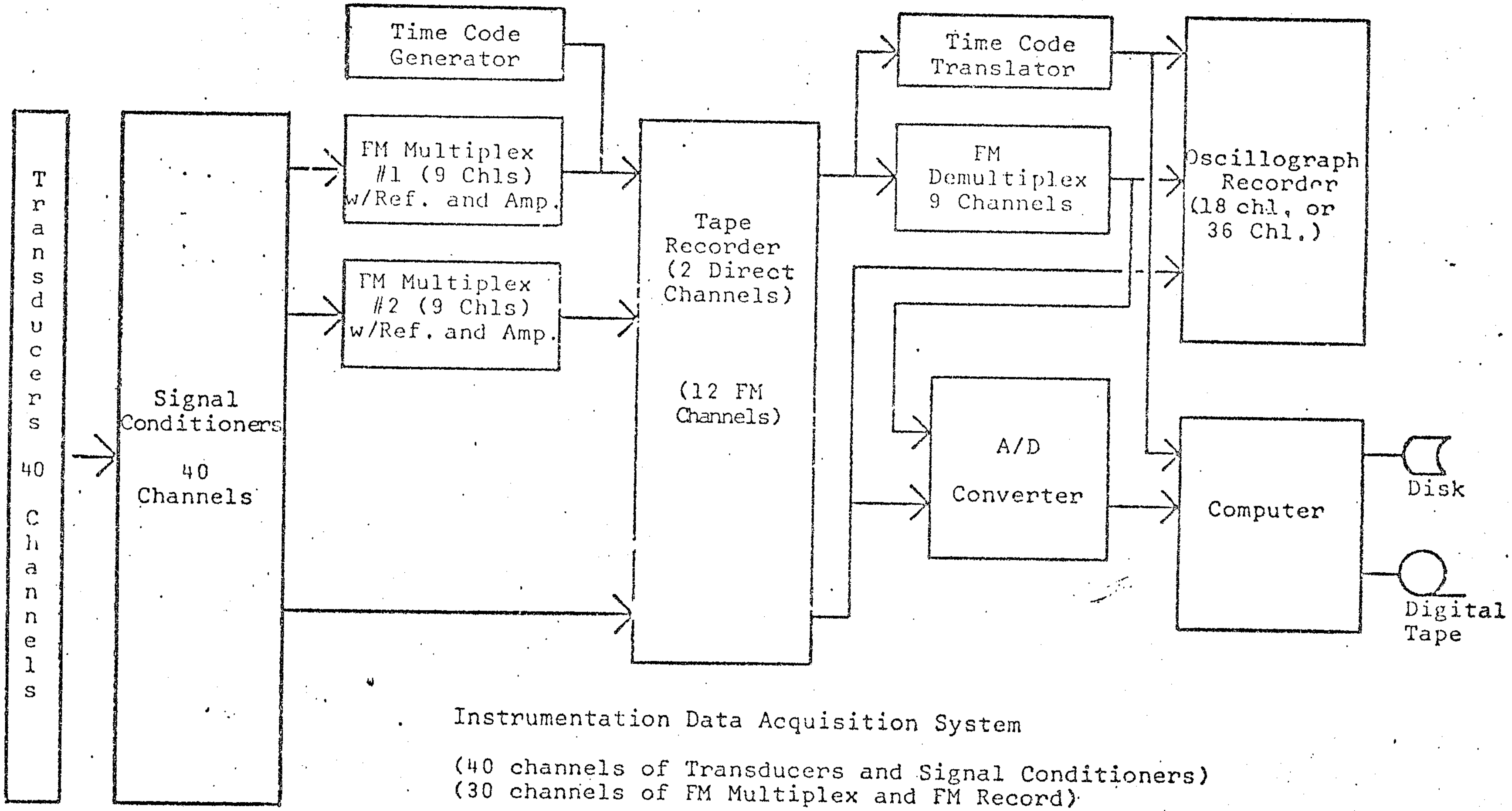
6.4 DESCRIPTOR MODULE

The function of the Descriptor Module is that of correlating inputs related to the data path of a measurement in such a way that validation of the data path may be done and that conversion to engineering units may be accomplished. Typical inputs will include:

a. VCO channel number

b. Filter number

c. Descriminator channel number



Instrumentation Data Acquisition System

(40 channels of Transducers and Signal Conditioners)
(30 channels of FM Multiplex and FM Record)

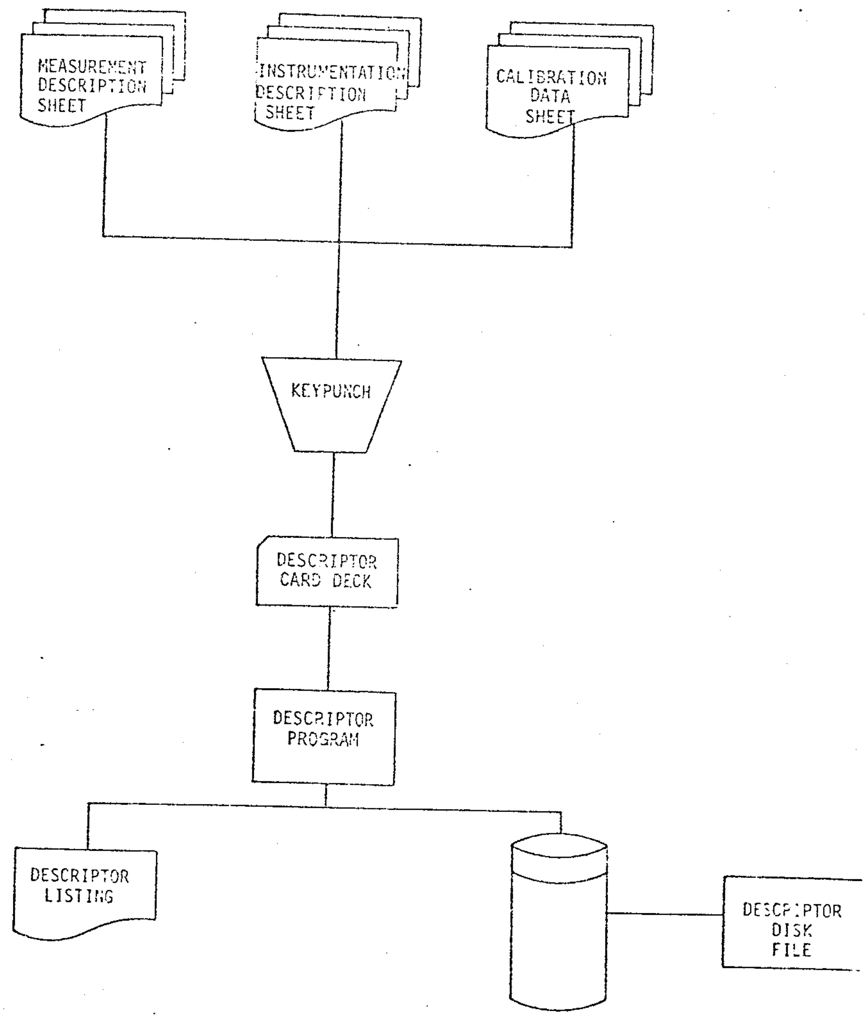
Figure D-1

IBM Flowcharting Worksheet

Printed in U.S.A.

Programmer: ______ Program No.: ______ Date: ______ Page: ______

Chart ID: ______ Chart Name: ______ Program Name: ______



Fold under at dotted line.

Fold under at dotted line.

Figure D-2

IBM Flowcharting Worksheet

Printed in U.S.A.

Programmer: ______ Program No.: ______ Date: ______ Page: ______

Chart ID: ______ Chart Name: ______ Program Name: ______

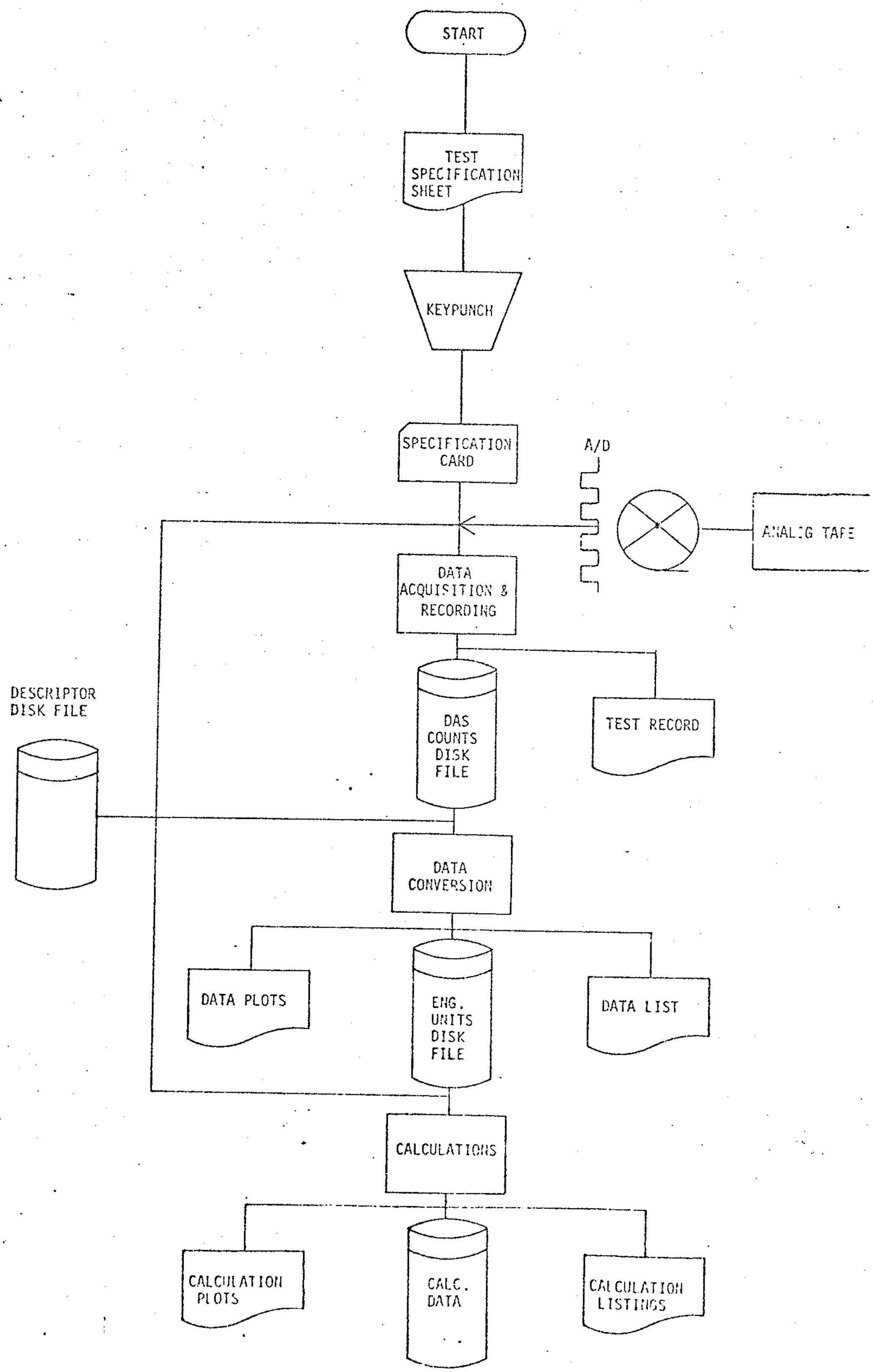


Figure D-3

d. A/D channel number

e. Transducer identification

f. Transducer calibration values

g. Calibration values for a, b, c, and d above, if appropriate.

h. Patching information

i. Measurement number

j. Measurement geometrical position

The correlated data will be displayed on a computer listed by the Statos-21 printer/plotter. (See attached examples in Appendix F).

6.5 DATA ACQUISITION AND RECORDING MODULE

The function of the Data Acquisition and Recording Module (DARM) is that of utilizing the hybrid hardware to monitor and digitize outputs from the analog system, and to record the data on disk for subsequent processing.

The main program will be written in FORTRAN IV. The program will call an assembly language program that will access and record the data on disk. The amount of data to be recorded in any one pass of the analog tape will depend upon the sample rate desired, the number of channels of interest, and the amount of elapsed time for which data is desired.

6.6 ENGINEERING UNIT CONVERSION MODULE

The function of Engineering Unit Conversion Module (EUCM) is that of converting raw data in integer Data Acquisition System (DAS) counts to computer oriented floating point numbers in engineering units for subsequent processing. A secondary function of the module will be to provide print and plot capability for the engineering unit data. The plots will provide the scaling capability to answer requirements 6.1 f.

6.7 CALCULATION MODULE

The function of the Calculation Module (CM) is that of providing simple, calculated results for printing and plotting. The structure of the module will be so optimized that response to user special calculation requirements will be based on minimum time and effort.

6.8 SOFTWARE DOCUMENTATION

6.8.1 Software documentation shall consist of program module level documentation as shown below:

a. Functional Description and Specification

b. Maintenance Manual

c. Demonstration test results

6.8.2 System documentation will include:

a. User Manual

b. Computer operations instructions

7.0 PHYSICAL PRE-TEST MEASUREMENT TECHNIQUES

7.1 LENGTH BETWEEN COUPLER FACES

7.2 LENGTH BETWEEN TRUCK CENTERS

7.3 VERTICAL PLAY OF COUPLER SHANK AT SILL AND KNUCKLE

7.4 COUPLER HEIGHT ABOVE RAIL

7.5 DETERMINATION OF HOPPER CAR CENTER OF GRAVITY AND PITCH MOMENT OF INERTIA

7.6 TRUCK STIFFNESS AND BOLSTER TRAVEL

7.7 VERTICAL SPRING RATE AND DEFLECTION CURVE

7.8 CAR TO CAR IMPACT/CALIBRATION TEST

7.0 PHYSICAL PRE-TEST MEASUREMENT TECHNIQUES

The Pre-Test Measurements defined are to be performed on selected tank and hopper cars associated with the Switchyard Impact Test Program. The data taken as a result of the measurements are to be recorded on Data Recording Sheets, Figure G-1. Prior to pre-test measurements RPI/AAR furnished hopper cars will be inspected jointly with the Missouri Paciffic Railroad representative and Transportation Test Center in accordance with Section 5.3 of this Test Specification.

7.1 LENGTH BETWEEN COUPLER FACES

a. Assure coupler knuckle is in closed position with coupler and draft gear slack removed in buff. (Compression)

b. Measure length between the outside coupler faces (not pulling face) using plumb bobs suspended from center of coupler faces over a 100 foot steel tape measure drawn taut on the floor beneath the car.

c. Record measurement.

7.2 LENGTH BETWEEN TRUCK CENTERS

a. Measure length between leading edge of A-End (leading end) bolster and B-End bolster outside side frame, using a 100 foot steel tape measure drawn taut. Take this measurement on each side of the car. NOTE: If leading edge of bolster is deformed or otherwise unsatisfactory for using as a reference, select another reference point which can be identified on both bolsters to make measurements between.

b. Record measurements.

7.3 VERTICAL PLAY OF COUPLER SHANK AT SILL AND KNUCKLE

a. Assure all coupler and draft gear slack is removed in buff at both ends of car.

DATE ______________________

DATA RECORDING SHEET

Test Program Title: ______________________

Pre-Test Measurement: ______________________

Test Measurement: ______________________

Post-Test Measurement: ______________________

Car Number: ______________________

ITEM	DATA DESCRIPTION	UNITS	VALUE	WORKED	VALIDATED

Figure G-1

b. Scribe a reference mark on face of striker plate centered over coupler shank and on vertical center of coupler face on A-End of car.

c. Place a reference bar across rails directly below coupler face.

d. Measure vertical distance between reference mark on striker plate and coupler shank with steel rule.

e. Record measurement.

f. Using a jack under the coupler, raise the coupler shank until it hits the striker plate.

g. Measure distance between reference mark on striker plate and coupler shank with steel rule.

h. Record measurement.

i. Measure distance between reference mark on coupler face and bottom of reference bar with steel rule.

j. Record measurement.

7.4 COUPLER HEIGHT ABOVE RAIL

a. Measure distance between reference mark on coupler face and bottom of reference bar, with steel rule. (Measurements must be within AAR Specification [32 1/2" - 35 1/2" empty, and 31 1/2" - 33 1/2" loaded]. If measurements are not within tolerance the coupler must be shimmed.)

b. Record measurements.

c. Repeat 7.3 a. through j. on B-End of car.

7.5 DETERMINATION OF HOPPER CAR CENTER OF GRAVITY AND PITCH MOMENT OF INERTIA

a. Attach plum bob and chalk line to top of pivot pin on A frame.

b. Attach two 10' - 7" x 3/4" diameter cables and two 16' - 5" x 1" diameter cables to A Frame pivot pin, using three washers per pin.

c. Move hopper car in place, install tie bar and two stringers. Lift hopper car free of trucks with two - 30 ton cranes attached to car lifting points. Attach four cables to cable pads on hopper car.

d. Lower hopper car until cables, attached to A Frame, take up car weight.

e. Remove crane cables from hopper car.

f. Let car settle till no movement is perceived.

g. Mark line of plumb bob on side of car. (Verify cables do not run on side of hopper car.)

h. Lift hopper car with two - 30 ton cranes attached to car lifting points until A Frame cables are slack.

i. Detach A Frame cables and lower car onto trucks.

j. Repeat 7.5 c. through i. with A Frame cables reversed.

k. Attach four 19' - 7" x 3/4" diameter cables to A Frame pivot pins using three washers per pin.

l. Lift hopper car with two - 30 ton cranes attached to car lifting points. Attach four cables to cable pads on hopper car.

m. Lower hopper car until cables attached to A Frame take up car weight.

n. Remove cable cranes from hopper car.

o. Verify cables do not rub on sides of hopper car.

p. Measure distance from top of A Frame pivot pin to hopper car center of gravity with steel tape as accurately as possible. Record distance.

q. Manually swing hopper car with tie ropes until the ± 5° amplitude is achieved. Release car and let swing free.

r. Record time for 5 cycles, 10 cycles, 15 cycles and 20 cycles, if possible. Record number of cycles to half amplitude and number of cycles to imperceptible motion.

s. Repeat steps q. through r. two times.

t. Lift hopper car with two - 30 ton cranes attached to car lifting points until A Frame cables are slack.

u. Detach A Frame cables and lower car onto trucks.

v. Record the following items on Data Recording Sheet: (Figure G-1)

ITEM	MEASUREMENT	UNIT OF MEASURE
j.	Coordinate of Hopper Car Center of Gravity:	
	Inches from center of car	Inches
	Inches above railhead	Inches
p.	Distance from top of A Frame pivot point to hopper car center of gravity	Inches
r.	Time for 5 cycles	Min/sec
	Time for 10 cycles	Min/sec
	Time for 15 cycles	Min/sec
	Time for 20 cycles	Min/sec
	Number of cycles to ± 2 1/2° amplitude	Cycles
	Number of cycles to imperceptible motion	Cycles
s.	Time for 5 cycles	Min/sec
	Time for 10 cycles	Min/sec
	Time for 15 cycles	Min/sec
	Time for 20 cycles	Min/sec
	Number of cycles to ± 2 1/2° amplitude	Cycles
	Number of cycles to imperceptible motion	Cycles
	Time for 5 cycles	Min/sec
	Time for 10 cycles	Min/sec
	Time for 15 cycles	Min/sec
	Time for 20 cycles	Min/sec
	Number of cycles to ± 2 1/2° amplitude	Cycles
	Number of cycles to imperceptible motion	Cycles

7.6 TRUCK STIFFNESS AND BOLSTER TRAVEL

a. Defined are the pre-test measurements to be performed on one tank car truck and one hopper car truck. The strain gauge channels of the hopper car truck are calibrated during the hopper car truck pre-test measurements. Data will be recorded on Data Recording Sheet (Figure G-1).

b. Assemble truck loading fixture near west end of bridge structure in Test Pit #2 (RDL).

c. Place truck to be tested on bridge structure and roll under loading fixture so the center plate is centered under the load pad of the loading fixture.

d. Place chocks fore and aft of truck wheel to prevent truck from moving along track.

e. Attach position transducer assembly to rail head and truck bolster.

f. Apply load to truck until springs are completely comress-ed, recording deflection of bolster and side frame at 10,000 pound increments starting at 0 pounds as indicated from load cell instrumentation. Spring group compression is detected by position transducers on each side of truck and side frame deflection is detected by dial indicating gauges on each side frame.

g. Record deflection of side frame and spring group when springs are completely compressed.

h. Unload truck until spring load is completely removed recording deflection of spring group and side frame at 10,000 pound increments as indicated from load cell in-strumentation.

i. Using 20 ton overhead hoist and sling, lift bolster until contact is made with both side frames.

j. Record position transducer readings.

k. Remove springs from spring nest. Tag springs by location for reinstallation into same location at later time.

l. Install steel blocks.

m. Lower truck bolster onto steel block and remove sling.

n. Apply load to truck at 10,000 pound increments starting at maximum load applied during Spring Group Stiffness Test, and increase to 100,000 pounds beyond starting load, recording load increase to 100,000 pounds beyond starting load, recording load from load cell instrumentation and deflection of bolster and side frames from dial indicating gauges. Plot load vs. side frame deflection during loading of truck to determine maximum load without yield of the truck side frame.

o. Unload truck until load is completely removed recording deflection of bolster and side frame at 10,000 pound increments down to starting load as indicated from load cell instrumentation.

p. Repeat steps f. through o. for hopper car truck, recording strain gauge readings as well as load cell, position transducer, and dial indicating gauge values.

7.7 VERTICAL SPRING RATE AND DEFLECTION CURVE

a. Position dial indicator gauges to measure movement of car body at six points (Appendix C)

b. Position jack under coupler.

c. Chock truck at non-lifted end of car.

d. Block springs to reduce car movement on springs.

e. Attach strain gauge instrumentation to hopper car strain gauges.

f. Calibrate strain gauge instrumentation (hopper car test only).

g. Apply upward force on car coupler in 5,000 pound increments until no load is applied to nearest center plate. Vertical upward force in all tank cars shall not exceed 50,000#.

h. Record movement of car body from dial indicators and strain of sill and shank strain gauges.

i. Record height of body bolster center plate when car center plate clears truck center plate.

j. Continue lifting coupler until center pin clears center plate and record height.

k. Plot deflection curve of hopper car and full tank car.

7.8 CAR TO CAR IMPACT/CALIBRATION TEST

a. Prepare two hopper cars. One with strain gauges on coupler shank and sill and the other to have a dynamometer coupler.

b. Two fully loaded tank cars. One with a dynamometer coupler.

c. Connect car-borne sensors to wayside recording instrumentation.

d. Connect speed traps to wayside recording instrumentation.

e. Calibrate car-borne sensors.

f. Calibrate wayside instrumentation.

g. Using locomotive or pusher, impact one hopper car at 4 and 6 mph into a standing identical hopper car with no brakes applied.

h. Record all standard hopper car instrumentation and dynamometer signals.

i. After cars have separated (both couplers are open), wayside brake trips will be used to stop the cars.

j. Impact one fully loaded tank car at 2 and 4 mph into a standing identical fully loaded tank car with no brakes applied.

k. Record dynamometer signal.

l. After cars have separated, wayside brake trips will be used to stop the cars.

8.0 INSTRUMENTATION TECHNIQUES

8.1 STRAIN GAUGES

8.2 DISPLACEMENT TRANSDUCERS

8.3 ACCELEROMETERS

8.4 LOAD CELLS

8.5 IMPACT SWITCH

8.6 INTERFACE CABLING - CONNECTION

8.7 SPECIAL INSTRUMENTATION

- 8.7.1 Electronic Speed Gates
- 8.7.2 Dynamometer Coupler

8.8 PHOTO INSTRUMENTATION

8.9 DATA ACQUISITION SYSTEM

- 8.9.1 Signal Conditioning Equipment
- 8.9.2 Multiplexing Equipment
- 8.9.3 Magnetic Tape Recorders
- 8.9.4 Strip Chart Recorders
- 8.9.5 Time Code Generation

8.0 INSTRUMENTATION TECHNIQUES

8.1 STRAIN GAUGES

a. Two hopper cars will be instrumented with twelve strain gauges each at the impact end only. One hopper car will act as a back-up or stand-by unit to be used in the event of failure or damage to the primary car. All strain gauges are of the weldable type consisting of a precision foil sensor bonded to a 300 series stainless steel carrier. These are extremely rugged type sensors designed especially for field test environments on massive steel structures. They are easily installed, with minimal surface preparation, by means of a miniature, portable spot welder. Suitable physical/environmental protection will be provided for each strain gauge.

b. The twelve strain gauges on each car will be mounted and connected as pairs, in a two-active arm bridge configuration. One pair will be mounted on the upper surface of the truck bolster to minotor vertical bending forces. (See Figure E-2) Three pairs will be mounted on the sill to measure impact bending forces. Two pairs will be mounted on the coupler shank just behind the coupler to measure longitudinal and bending forces applied to the coupler. All strain gauges will be statically calibrated during pre-test measurements.

8.2 DISPLACEMENT TRANSDUCERS

Nine position-displacement transducers (string pots) will be installed on the hopper car to monitor linear displacements

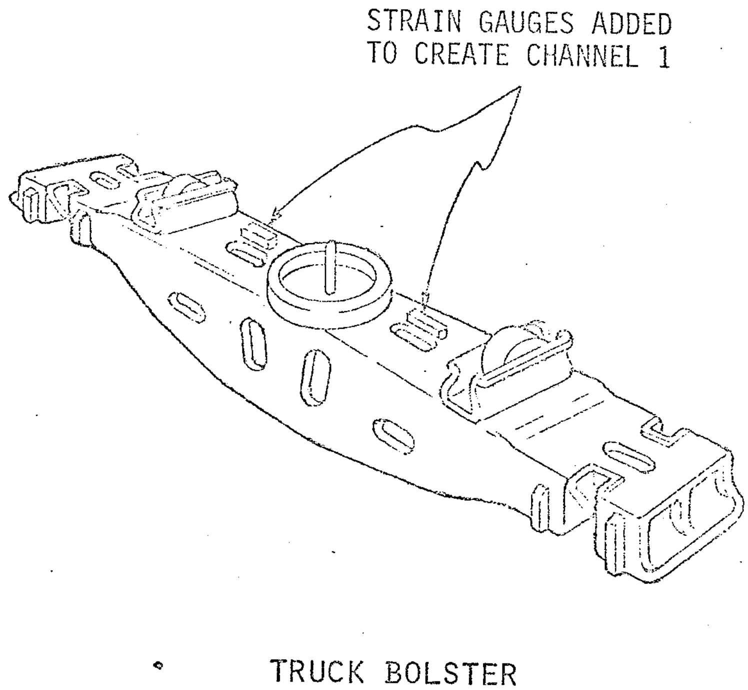
(See Figure E-4). Four pairs of the transducers will be mounted to measure body to side frame deflection at each corner of the hopper car. The remaining transducer will be mounted to measure the longitudinal displacement of the the impacted coupler relative to the hopper car body.

8.3 ACCELEROMETERS

A single piezoresistive accelerometer capable of measuring accelerations of ± 50 G will be mounted in a protective housing on the upper forward surface of the hopper car sill. It will be positioned precisely to monitor longitudinal impact accelerations. (See Figure E-4)

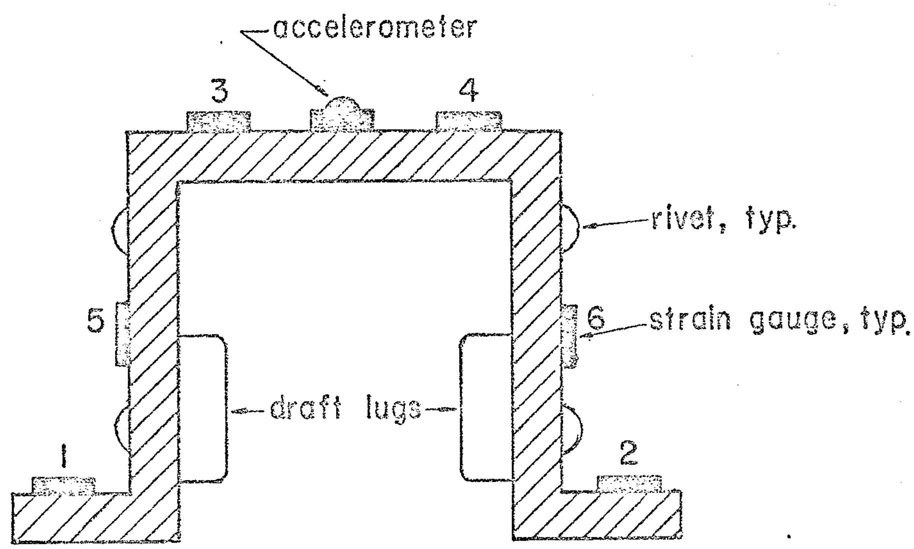
8.4 LOAD CELLS

Calibrated load cells will be used for pre-test measurements of truck spring and bolster stiffness. A single 200,000 pound load cell will be employed to measure the force applied to produce "bottoming-out" of the truck springs. Truck bolster strain gauge readings will be correlated with the load cell readings in step increments for calibration purposes. The load will then be removed and the spring groups replaced by structural blocks. A maximum force of 200 Kips will then be reapplied in incremental steps of 10,000 pounds to determine truck side frame and bolster spring rate beyond spring bottoming conditions. Again, truck bolster strain gauge readings will be taken and correlated with load cell force measurements for calibration of the truck bolster strain gauge system.

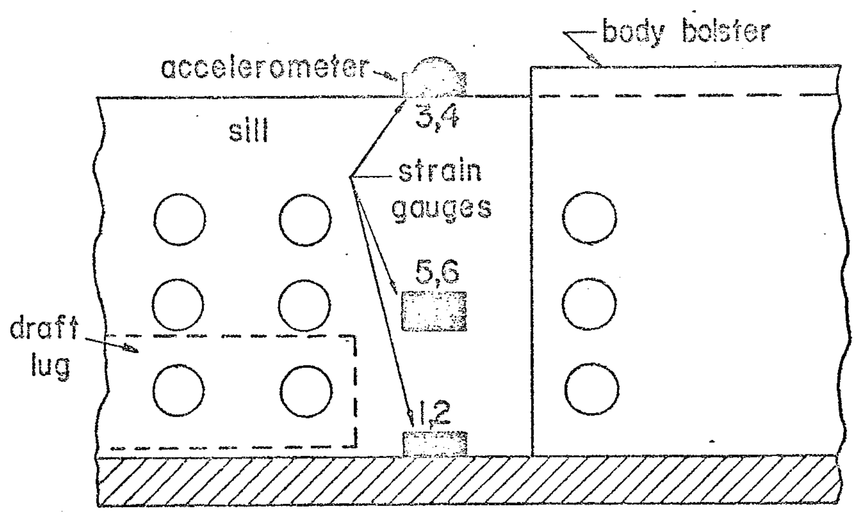


LOCATION OF STRAIN GAUGES
ON HOPPER CAR TRUCK (IMPACT END)

Figure E-1



END VIEW



SIDE VIEW

gauges 1 through 6 added for channel (2) (1+2+3+4+5+6)
gauges 1 through 4 subtracted for channel (3) (3+4-1-2)
accelerometer is channel (4)

Fig. E-2 - Location of Strain Gauges and Accelerometer on Sill

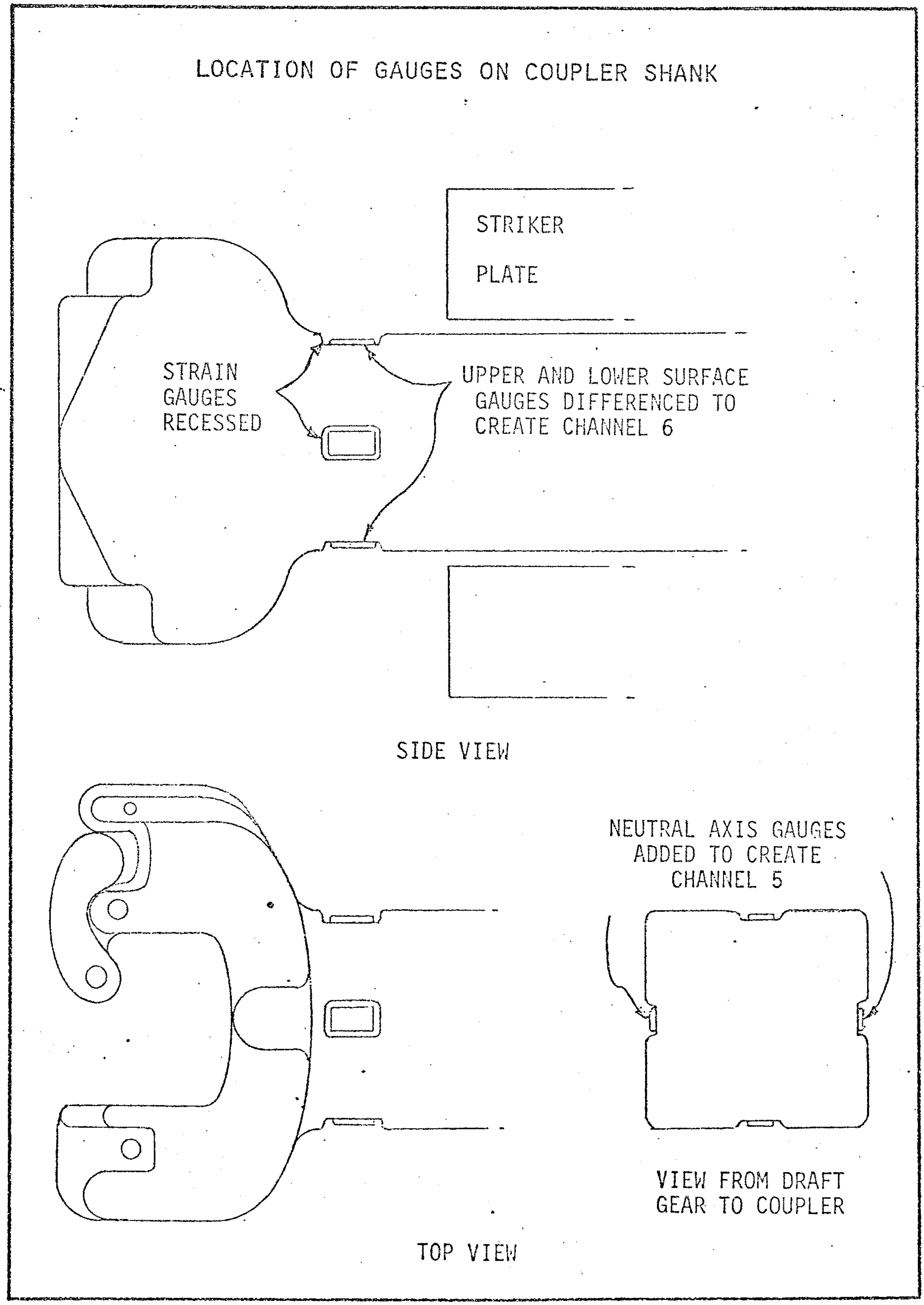
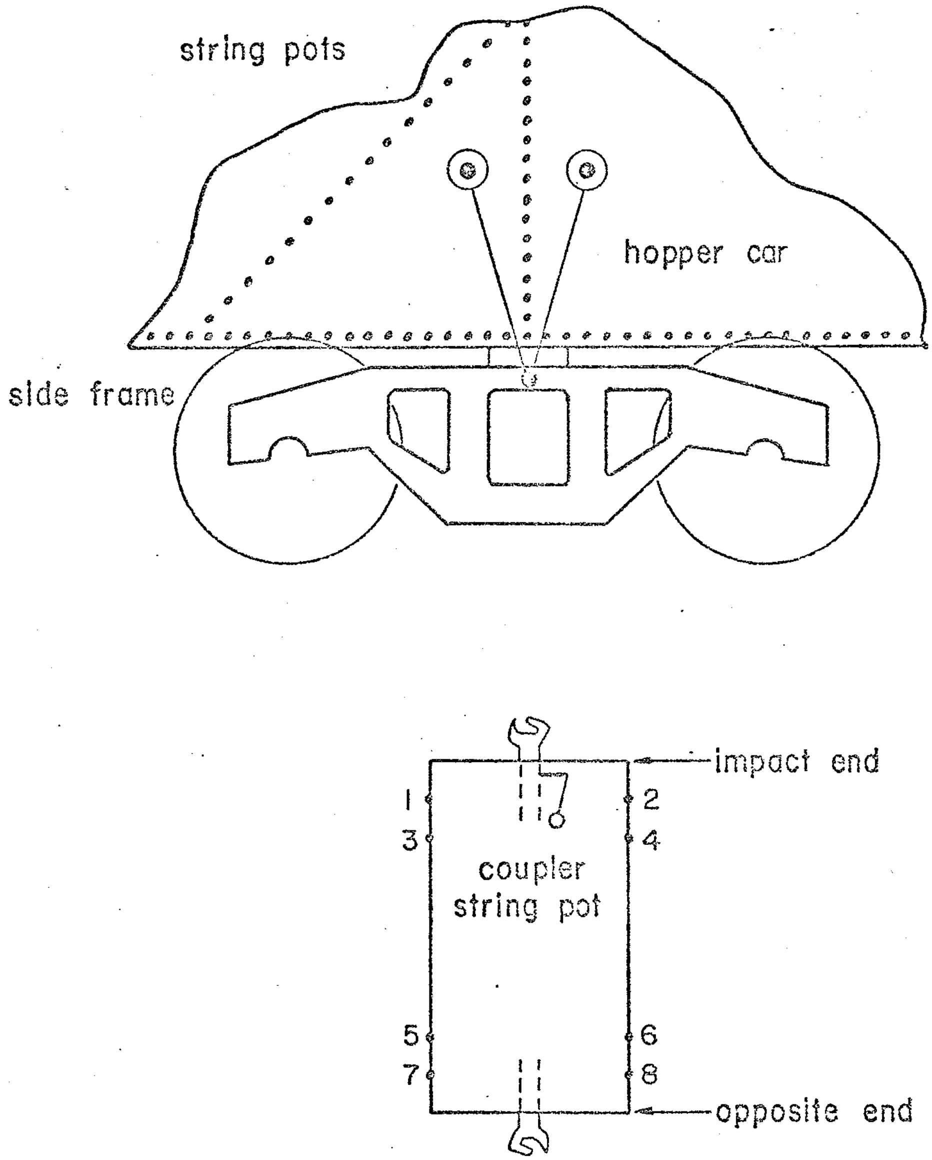

LOCATION OF GAUGES ON COUPLER SHANK
STRIKER
PLATE
STRAIN
GAUGES
RECESSED
UPPER AND LOWER SURFACE
GAUGES DIFFERENCED TO
CREATE CHANNEL 6
SIDE VIEW
NEUTRAL AXIS GAUGES
ADDED TO CREATE
CHANNEL 5
VIEW FROM DRAFT
GEAR TO COUPLER
TOP VIEW

Figure E-3



deflections	1 plus 2	form	channel (7)
deflections	3 plus 4	form	channel (8)
deflections	5 plus 6	form	channel (9)
deflections	7 plus 8	form	channel (10)
deflections	coupler	form	channel (11)

Fig. E-4 Location of string pots

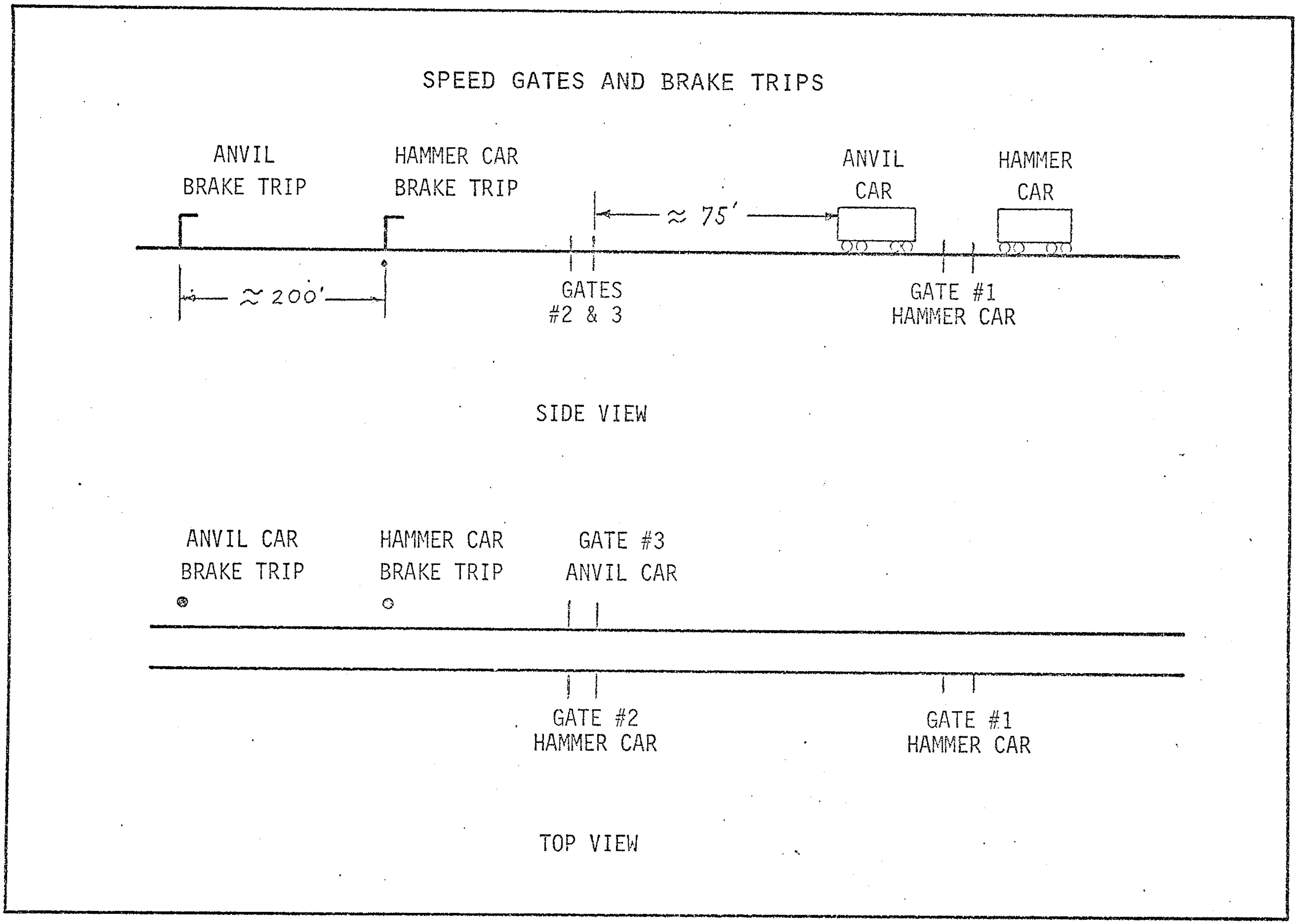

SPEED GATES AND BRAKE TRIPS
ANVIL
BRAKE TRIP
HAMMER CAR
BRAKE TRIP
≈ 75'
ANVIL
CAR
HAMMER
CAR
≈ 200'
GATES
#2 & 3
GATE #1
HAMMER CAR
SIDE VIEW
ANVIL CAR
BRAKE TRIP
HAMMER CAR
BRAKE TRIP
GATE #3
ANVIL CAR
GATE #2
HAMMER CAR
GATE #1
HAMMER CAR
TOP VIEW

Figure E-5

8.5 IMPACT SWITCH

A microswitch will be mounted in the vicinity of the coupler on the impact end of the hopper car. This switch will be positioned, with an expendable "cat Whisker" type operator, in such a manner that it will be operated at the instant of first contact between the couplers of the tank car and the hopper car. This operation will then produce a pulse type reference marker to be recorded on the magnetic tape and strip chart recorders.

8.6 INTERFACE CABLING - CONNECTION

a. Three 20 pair, individually shielded pair instrumentation cables approximately 500 foot long will be laid between a wayside junction terminal box located beside the track in the impact zone and a similar junction terminal box inside the data trailer located about 500 feet back from the impact zone. This arrangement will then provide a total of 60 individually shielded pairs from trackside to the data trailer. The junction boxes will be of the weatherproof type with suitable connectors to adapt to either end of the 500 foot cables. Sufficient terminal strips will be mounted inside the junction boxes to facilitate any additional inter-face wiring and cabling required to complete connections to the transducers or the signal conditioner inputs.

b. Individual shielded cables will be used to connect the signal conditioning equipment in the data trailer to the junction box cabling to the trackside junction box.

8.7 SPECIAL INSTRUMENTATION

8.7.1 Electronic Speed Gates

a. An electronic speed gate has been developed and tested at the TTC especially for precision measurement of rail car velocities in impact test configurations. This speed gate consists primarily of an industrial type limit switch with a one-way, "cat whisker" type operator on an adjustable mounting bracket attached to a rail tie in such a position as to be triggered by the over hanging outside edge or a rail car wheel. A "one-shot" multivibrator and a flip-flop integrated circuit along with a voltage regulator complete the electronic package for each speed gate.

b. The method used by this type speed gate to determine a rail car's velocity is to accurately detect a wheel passing the location of the limit switch. Thus, on the forward truck of a rail car, two wheel crossings would occur, and the exact distance of spacing between the two wheel is known. Therefore, if each wheel detection is recorded and presented simultaneously with an accurate timing signal such as IRIG-B time code, then the data reduction simply becomes $V = \frac{dn}{dt}$ where velocity equals the distance (wheel spacing) divided by the time (in milliseconds) between the two wheel detection pulses.

c. Three such speed gates will be employed in the Impact Zone. They will be positioned in such a manner as to precisely determine (by time-data reduction) the exact speed of: (1) the tank car immediately prior to impact; (2) the tank car after impact (at some point to be determined); and (3) the hopper car after impact. Refer to Figure F-1 for Speed Calculations.

8.7.2 Dynamometer Coupler

An AAR instrumented and certified strain gauge dynamometer coupler will be installed alternately on a hopper car and a tank car for preliminary car-into-car impacts (See Appendix D). Longitudinal force measurements will be obtained from this coupler.

8.8 PHOTO INSTRUMENTATION

a. A remote camera control system has been designed, developed and tested at the TTC for use with impact test projects. With this system, long-line remote control of up to twelve high speed cameras, including start, stop, timing synchronization, etc. can easily and reliably be accomplished. This system will be used to control seven high speed motion picture cameras for the dynamic test series.

b. Timing synchronization will be provided each camera from the central IRIG-B timing signal source. This will permit exact correlation of each photo frame with all recorded data from the transducers.

SPEED TRAP SPECIFICATION DATA

Miles Per Hour	Feet Per Second	SWITCH INTERVAL - TIME (SECONDS)				
		1 ft	2 ft	3 ft	4 ft	5 ft
2	2.93	0.341	0.683	1.024	1.365	1.706
4	5.87	0.170	0.341	0.511	0.681	0.852
6	8.80	0.114	0.227	0.341	0.445	0.568
8	11.73	0.085	0.171	0.256	0.341	0.426
10	14.67	0.068	0.136	0.204	0.273	0.341
12	17.60	0.057	0.114	0.170	0.227	0.284
14	20.53	0.049	0.097	0.146	0.195	0.244
16	23.47	0.043	0.085	0.128	0.170	0.213
18	26.40	0.038	0.076	0.114	0.152	0.189
20	29.33	0.034	0.068	0.102	0.136	0.170
22	32.27	0.031	0.062	0.093	0.124	0.155
24	35.20	0.028	0.057	0.085	0.114	0.142
26	38.13	0.026	0.052	0.079	0.105	0.131
28	41.07	0.024	0.049	0.073	0.097	0.122
30	44.00	0.023	0.045	0.068	0.091	0.114
32	46.93	0.021	0.043	0.064	0.085	0.107
34	40.87	0.020	0.040	0.060	0.080	0.100
36	52.80	0.019	0.038	0.057	0.076	0.095
38	55.73	0.018	0.036	0.054	0.072	0.090
40	58.67	0.017	0.034	0.051	0.068	0.085
42	61.60	0.016	0.032	0.049	0.065	0.081
44	64.53	0.015	0.031	0.046	0.062	0.077
46	67.47	0.015	0.030	0.044	0.059	0.074
48	70.40	0.014	0.028	0.043	0.057	0.071
50	73.33	0.014	0.027	0.041	0.055	0.068

Figure F-1

8.9 DATA ACQUISITION SYSTEM

8.9.1 Signal Conditioning Equipment

A separate signal conditioning amplifier will be provided for each transducer, sensor or timing signal required. These signal conditioners are the Dynamics 7600 series and include selectable filtering, isolated input-output circuits and separate, individually controllable outputs for magnetic tape recorder, galvanometer (or strip chart recorder) and VCO's (Voltage Controlled Oscillator for multiplexing). The signal conditioner also provides a controllable excitation or operating voltage source (0-30 VDC) for each transducer as well as a convenient means of controlling set-up calibration, balance and output signal levels.

8.9.2 Multiplexing Equipment

A nine channel multiplex/demultiplex system consisting of IRIG constant bandwidth channels 1A through 9A manufactured by Metroplex Corp. will be used to multiplex and record up to nine channels of test data. The frequency response of the nine multiplexed channels is 1 KHz. An autoset calibration system is included to adjust bandcenter and check upper bandwidth of channel prior to recording or reproducing data. Pre and Post-test calibrations will be recorded on magnetic tape along with the data.

8.9.3 Magnetic Tape Recorders

a. One Bell and Howell CPR4010 14 track tape recorder with 12 FM record/reproduce channels and 2 direct record/reproduce channels. The multiplexed data will be recorded on the FM tape channels. The frequency response of the FM tape channels is 10KHz at the 30 IPS tape speed which will be the recording speed.

b. An Ampex FR 2000 tape recorder with reproduce channels compatible with the Bell and Howell 4010 will be used to reproduce the data for data reduction.

8.9.4 Strip Chart Recorders

a. 100% back-up of all recorded data will be provided by strip chart recorders. The primary instrument of this type to be employed is the Bell and Howell Model 5-134 Oscillographic Recorder. This is an 18 channel system and will use fluid damped galvanometers capable of up to 5 KHz frequency response. These are light-beam type galvanometers and will be used with an ultra-violet developing type of light sensitive recording chart paper. No more than 12 channels of data, including IRIG-B timing will be recorded on the oscillograph. The additional data channels will be recorded in real time on an eight channel pen type strip chart recorder.

b. The strip chart/oscillographic recording of all data channels will provide an immediate, quick-look data read out for field inspection and instrumentation check-out/verification prior to final data reduction and analysis of the simultaneously recorded analog magnetic tape data.

8.9.5 Time Code Generation

A time code generator and translator manufactured by Datum will be used to provide IRIG-B timing. This will be recorded on a selected tape channel during test to ensure correct time correlation of test data during data reduction. In addition to the IRIG-B time code format, slow codes at 1 PPS, 10 PPS and 1000 PPS and digital out-puts are provided for use during recording and data reduction.

9.0 PHOTOGRAPHY TECHNIQUES

9.0 PHOTOGRAPHY TECHNIQUES

a. The Photo Instrumentation group will support the tests with a maximum of eleven motion picture cameras, one CCTV camera and a portable TV camera. This is in addition to the still coverage available.

b. The eleven motion picture cameras are made up of the following:

   7 - 16mm Locams, variable from 24 to 500 FPS

   1 - 16mm Milliken, variable from 24 to 500 FPS

   1 - 16mm Milliken, capable of either 128 or 400 FPS

   1 - 16mm Arriflex, variable from 24 to 50 FPS

   1 - 16mm Arriflex, capable of 24 FPS

c. The seven Locams will be used for prime coverage. The two Millikens will be used for backup.

d. The exact location and number of cameras for each test will be determined as far in advance as possible. Due to the change of location of various test cars in the consist each camera station location will have to be determined precisely at the time of test. During the preliminary tests, it is expected that less than seven high speed cameras will be used. The later series will require the maximum high speed coverage. IRIG-B timing will be provided to all high speed camera stations.

e. The photographic data will be recorded for each camera station and compiled in real time. This data will include items such as camera status, number, position, frame rate, focal length of lens, f stop, etc.

f. Red and white square targets will be placed to enhance phtotography.

g. Target distances and positions will be recorded.

h. Best CCTV coverage will be determined for each test. The CCTV coverage will be utilized for quick look data.

j. 16 mm Ektachrome EF daylight ASA 160 will be used as prime instrumentation film. 16mm Ektachrome MS ASA 64 will be used for documentation coverage. The motion picture film will be processed off-site.

k. Camera stations will be numbered sequentially. Starting at the northern part of the test track and working south, the odd numbers will be on the west side of the track and the even numbers on the east side. To differentiate camera station, CC will indicate CCTV; D will indicate documentary coverage and instrumentation cameras will be numbered.

Example: Sta. 1 would be an instrumentation camera stationed on the northwest side of the track. Sta. CC 2 would be a CCTV stationed on the east side of the track. In addition, each camera station will be referenced to a master surveyed grid map. The coordinate data for each station will be compiled for each test and a map will be prepared indicating each camera station.

APPENDICES

Appendix A	List of Instrumentation
Appendix B	Truck Spring Bolster Stiffness
Appendix C	Coupler Vertical Spring Rate
Appendix D	Car Into Car Impacts
Appendix E	Manipulation of Data Channels
Appendix F	Listing of Plot Example
Appendix G	Drawings for Equipment
Appendix H	Important Correspondence
	Index to Appendix H

LIST OF INSTRUMENTATION

MEASUREMENT DEVICE	LOCATION	NUMBER	CALIBRATION
Strain Gauge	Truck on impact end of hopper car (Fig. E-1)	2	100 Kips ± 10% on bolster
Strain Gauge	Sill on impact end of hopper car (Fig. E-2)	6	1 1/4 Kips 10%
Strain Gauge	Shank of coupler on hopper impact end, recessed (Fig. E-3)	4	1 1/4 Kips ± 10%
Accelerometer	Impact end of hopper car sill near strain gauges (Fig. E-2)	1	50 g's ± 10%
String Pot	Body to side frame on each corner of hopper (Fig. E-4)	8	-3" to +9" ± 1/10"
String Pot	Coupler longitudinal displacement on impact end of hopper	1	-2" to +4" ± 1/10"
Dynamometer Coupler	Impact end of hopper car pre-test only	1	- - -
Speed Gates	Track before and after impact location (Fig E-5)	2	0 -35 mph ± 1/10 mph
Dial Gauges	Car underframe to reference (Appendixes B and C)		- - -
Calibrated Cylinder	Truck bolster and coupler (Appendixes B and C)	1	400 Kips ± 1 Kip

CHANNEL NUMBER	DESCRIPTION
1.	Bolster bending
2.	Sum of strain measurements in sill
3.	Difference of strain measurements in sill
4.	Sill Accelerometer
5.	Longitudinal coupler force
6.	Coupler bending
7.	Body to side frame deflection
8.	Body to side frame deflection
9.	Body to side frame deflection
10.	Body to side frame deflection
11.	Coupler longitudinal displacement
12.	IRIG-B Time Code
13.	Speed Gate Signal
14.	Speed Gate Signal
15.	Impact Indicator

When measurements are indicated as added or subtracted to form a channel, they may alternately be measured as separate channels and added in the data reduction. Channels are designated as C_1 through C_{20}.

Appendix B: Truck Spring and Bolster Stiffness

One truck from the hopper car and one from the tank car will be loaded by a load cell in tension as shown in Figure B-1. String pots will be used to measure the deflection between the truck bolster and reference bars that are clamped to the wheels. The reference bars will be stiff enough to have negligible deflection. The force will be incrementally increased and force and deflection and bolster strain gauge readings will be recorded until the springs bottom.

The load will then be removed and the springs replaced with blocks. The loading will then be resumed with dial indicators used to measure the bolster deflection with respect to the reference bar. The load will be incrementally increased to 50-100 kips beyond the load required to bottom the springs. Again, dial gauges and strain readings will be recorded.

The bolster and side frames tend to shift and roll under load, and the vertical displacement measurements must be taken with care so that the side frame shift or roll is not inadvertently measured as vertical deflection.

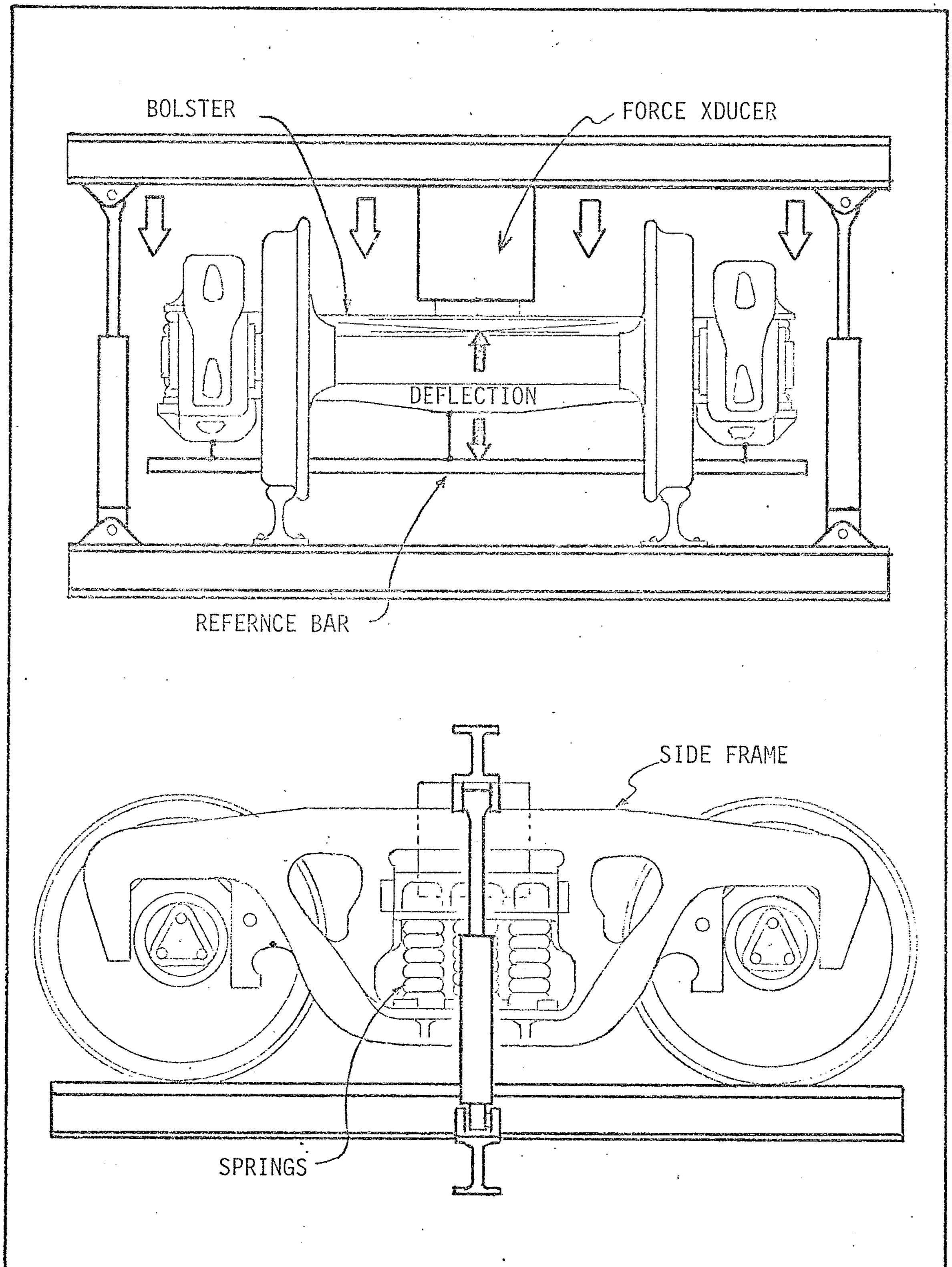
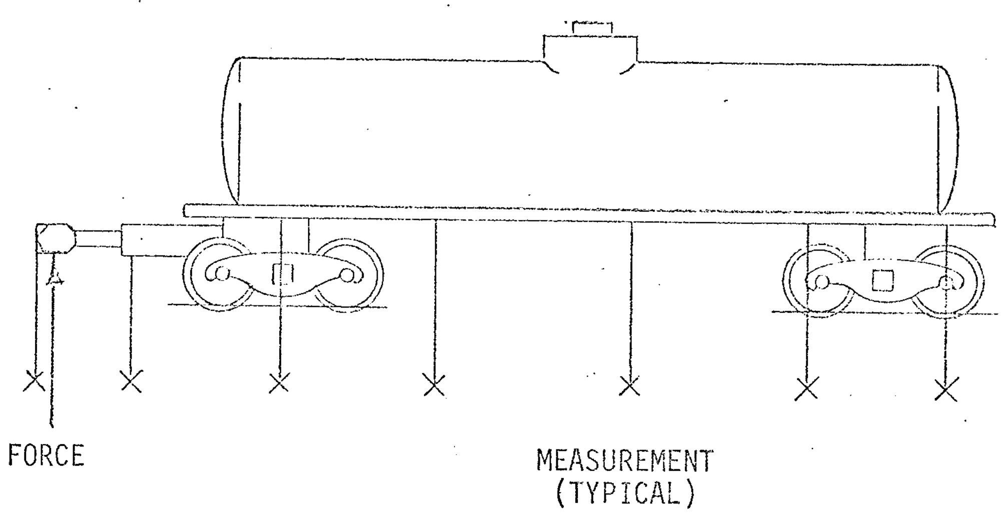

BOLSTER
FORCE XDUCER
DEFLECTION
REFERNCE BAR
SIDE FRAME
SPRINGS

FIG. B-1

Appendix C: Coupler Vertical Spring Rate

Apply an upward force on one car coupler in 5,000 pound increments until no load is applied on the nearest center plate (car off of bolster). Measure movement of car body at 6 points shown below using dial indicators with reference to striker face. Truck springs should be blocked to reduce car body movement on springs. Report spring rate of structure in bending and deflection curve



During application of loads, the strain gauge readings in the coupler and sill will be recorded for the hopper car.

Two series of tests are to be performed as follows:

Light car at 0 psi (no water load).

Appendix D: Car Into Car Impacts

A standing car with no brakes applied will be impacted by an identical car moving at a specified impact speed. Draft gear will be blocked on both cars. For the hopper car into hopper car impacts, these speeds will be 5 mph and 10 mph. For the impacts between fully loaded tank cars, impact speeds will be 2 mph and 4 mph. In each test, one of the cars will be instrumented with a dynamometer coupler and longitudinal force measured. In addition, speed in and out for the impacting car and speed out for the impacted car will be recorded (Figure A-5). In the hopper car impacts, all standard hopper car instrumentation will be in operation and will be recorded. After the cars have separated (both couplers are open and cut bars tied up in this test), wayside brake trips will be used to stop the cars. Tank cars are to be pressurized to 100 psi and loaded to 62.7% water equivalent to GRL of 263,000#. 60° F temperature of H_2O is not required for these tests.

Appendix E: Manipulation of Data Channels

1. In the truck spring rate test, a calibration constant will be determined to convert channel 1 to truck force.

$$\text{Truck Force} = K_1C_1$$

2. In the equal car impact tests, dynamometer coupler readings will be compared with channels 2, 3, and 4 to give relations between longitudinal force (f_L) and strain on the sill. Similarly, the vertical coupler spring rate test will be used to determine the relationship between vertical force (f_V) and channels 2, 3, and 6. Third, a compression test of the coupler will be used to determine the relationship between horizontal force and channel 5. These will yield coefficients A_{ij} and b_{ij} as shown below.

$$C_2 = A_{11}f_L+A_{12}f_V$$

$$C_3 = A_{21}f_L+A_{22}f_V$$

$$C_4 = g(f_L)$$

$$C_5 = b_{11}f_L+b_{12}f_V$$

$$C_6 = b_{21}f_L+B_{22}f_V$$

Coefficient	Test in Which Determined
A_{11}	hopper into hopper
A_{12}	vertical srping rate
A_{21}	hopper into hopper
A_{22}	vertical spring rate
$g(f_L)$	hopper tinto hopper
b_{11}	coupler compression test
b_{12}	vertical spring rate
b_{21}	=0 from theory
b_{22}	vertical spring rate of coupler

The equation can then be inverted to give:

$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix}^{-1} = \begin{vmatrix} \bar{A}_{11} & \bar{A}_{12} \\ \bar{A}_{21} & \bar{A}_{22} \end{vmatrix}$$

$$\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}^{-1} = \begin{vmatrix} \bar{b}_{11} & \bar{b}_{12} \\ \bar{b}_{21} & \bar{b}_{22} \end{vmatrix}$$

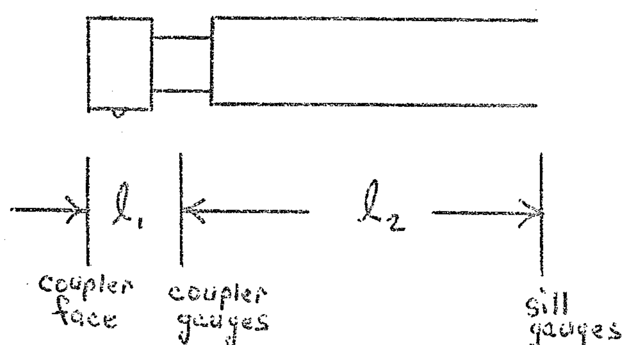
Thus, horizontal and vertical force can be calculated from the channels.

$$f_L = \bar{A}_{11} C_2 + \bar{A}_{12} C_3$$

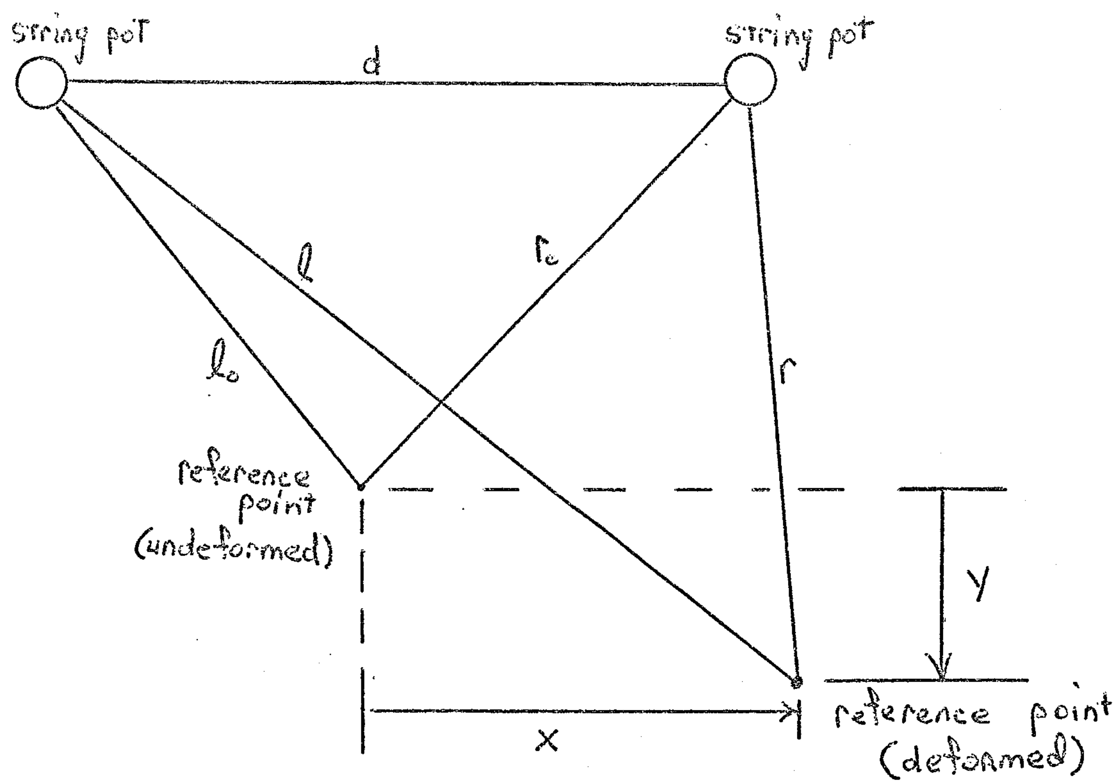
$$f_L = \bar{b}_{11} C_5 + \bar{b}_{12} C_6$$

$$f_L = g^{-1}(C_4)$$

$$f_v = \left(1 + \frac{\ell_1}{\ell_2}\right)\left(\bar{A}_{12} C_2 + \bar{A}_{22} C_3\right) - \frac{\ell_1}{\ell_2}\left(\bar{b}_{12} C_5 + \bar{b}_{22} C_6\right)$$



3. The final data manipulation will consist of converting string pot displacements to horizontal and vertical displacements. This can be done as shown below:

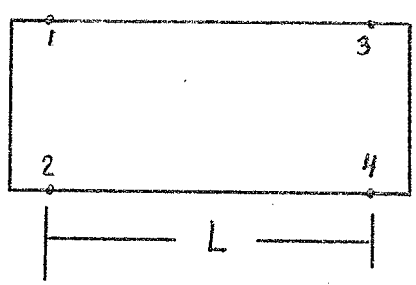


$$X = \frac{(\ell - r)(\ell + r)}{2d} - \frac{(\ell_o - r_o)(\ell_o + r_o)}{2d}$$

$$Y = \frac{\sqrt{(r+\ell-d)(r+\ell+d)(-r+\ell+d)(r-\ell+d)}}{2d}$$

$$- \frac{\sqrt{(r_o+\ell_o-d)(r_o+\ell_o+d)(-r_o+\ell_o+d)(r_o-\ell_o+d)}}{2d}$$

The total car lateral motion (X), heave motion (Y), and roll motion (φ) can then be determined from the x and y motions of each corner.



$$X = \frac{X_1 + X_2 + X_3 + X_4}{2}$$

$$Y = \frac{Y_1 + Y_2 + Y_3 + Y_4}{2}$$

$$\phi = \arcsin \left[\frac{(Y_1 + Y_2) - (Y_3 + Y_4)}{L} \right]$$

APPENDIX F

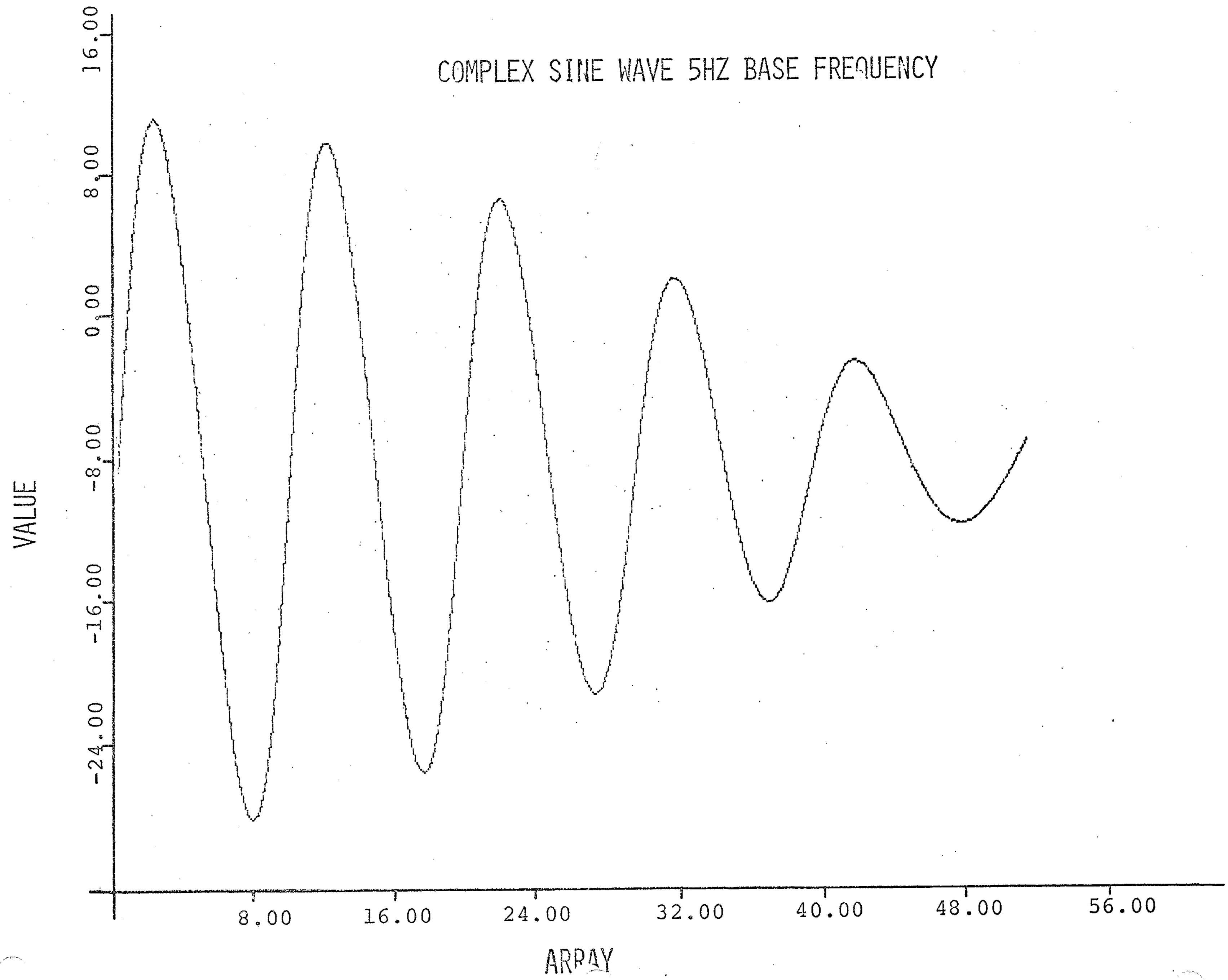
LISTING AND PLOT EXAMPLE

RPI-AAR SWITCHYARD SAFETY PROGRAM (PHASE 15)

TEST 1 SERIES 1 RUN 1

07/18/75

TIME (SEC)	MEASUREMENT NUMBER 1	2	3	4	5	6	7	8
0.000	.70E 00	.27E 00	.31E 00	.42E 00	.69E 00	.35E 00	.91E 00	.35E 00
.001	.84E 00	.94E 00	.62E-01	.91E 00	.92E 00	.30E 00	.51E 00	.37E 00
.002	.67E 00	.67E 00	.10E 01	.97E 00	.84E 00	.31E 00	.29E 00	.96E 00
.003	.18E 00	.46E 00	.12E 00	.59E 00	.45E 00	.38E 00	.25E 00	.11E 00
.004	.38E 00	.31E 00	.43E 00	.77E 00	.74E 00	.51E 00	.41E 00	.82E 00
.005	.27E 00	.23E 00	.93E 00	.51E 00	.72E 00	.71E 00	.75E 00	.98E-01
.006	.85E 00	.21E 00	.61E 00	.82E 00	.39E 00	.97E 00	.28E 00	.94E 00
.007	.11E 00	.25E 00	.49E 00	.69E 00	.75E 00	.29E 00	.99E 00	.34E 00
.008	.63E-01	.35E 00	.55E 00	.12E 00	.80E 00	.68E 00	.90E 00	.30E 00
.009	.70E 00	.52E 00	.80E 00	.12E 00	.53E 00	.12E 00	.99E 00	.82E 00
.010	.28E-01	.75E 00	.23E 00	.67E 00	.95E 00	.63E 00	.27E 00	.91E 00
.011	.41E-01	.38E-01	.86E 00	.79E 00	.56E-01	.21E 00	.74E 00	.56E 00
.012	.74E 00	.39E 00	.67E 00	.47E 00	.85E 00	.84E 00	.39E 00	.78E 00
.013	.13E 00	.81E 00	.66E 00	.72E 00	.33E 00	.54E 00	.23E 00	.55E 00
.014	.21E 00	.29E 00	.85E 00	.52E 00	.50E 00	.30E 00	.26E 00	.89E 00
.015	.97E 00	.83E 00	.22E 00	.89E 00	.36E 00	.12E 00	.48E 00	.79E 00
.016	.42E 00	.43E 00	.78E 00	.83E 00	.91E 00	.54E-02	.88E 00	.25E 00
.017	.56E 00	.96E-01	.53E 00	.32E 00	.14E 00	.95E 00	.48E 00	.28E 00
.018	.39E 00	.82E 00	.47E 00	.38E 00	.58E-01	.96E 00	.25E 00	.87E 00
.019	.90E 00	.62E 00	.59E 00	.10E 01	.67E 00	.35E-01	.22E 00	.16E-01
.020	.10E 00	.47E 00	.90E 00	.18E 00	.96E 00	.17E 00	.38E 00	.73E 00
.021	.99E 00	.39E 00	.40E 00	.92E 00	.94E 00	.37E 00	.72E 00	.40E-02
.022	.57E 00	.36E 00	.84E-01	.23E 00	.61E 00	.63E 00	.25E 00	.84E 00
.023	.83E 00	.40E 00	.96E 00	.97E-01	.97E 00	.95E 00	.96E 00	.24E 00
.024	.78E 00	.51E 00	.17E-01	.53E 00	.15E-01	.33E 00	.87E 00	.21E 00
.025	.42E 00	.67E 00	.27E 00	.52E 00	.75E 00	.78E 00	.96E 00	.73E 00
.026	.75E 00	.90E 00	.70E 00	.79E-01	.17E 00	.29E 00	.24E 00	.82E 00
.027	.76E 00	.19E 00	.32E 00	.20E 00	.27E 00	.86E 00	.71E 00	.47E 00
.028	.46E 00	.55E 00	.13E 00	.88E 00	.70E-01	.50E 00	.36E 00	.62E 00
.029	.85E 00	.96E 00	.13E 00	.12E 00	.55E 00	.19E 00	.20E 00	.46E 00
.030	.93E 00	.44E 00	.32E 00	.93E 00	.72E 00	.95E 00	.23E 00	.80E 00
.031	.69E 00	.98E 00	.69E 00	.30E 00	.58E 00	.78E 00	.45E 00	.70E 00
.032	.14E 00	.59E 00	.25E 00	.23E 00	.12E 00	.66E 00	.85E 00	.16E 00
.033	.28E 00	.25E 00	.10E 01	.73E 00	.36E 00	.61E 00	.44E 00	.18E 00
.034	.11E 00	.98E 00	.94E 00	.78E 00	.28E 00	.62E 00	.22E 00	.77E 00
.035	.62E 00	.77E 00	.58E-01	.40E 00	.88E 00	.69E 00	.19E 00	.92E 00
.036	.82E 00	.63E 00	.37E 00	.58E 00	.18E 00	.83E 00	.34E 00	.63E 00
.037	.71E 00	.54E 00	.87E 00	.33E 00	.16E 00	.23E-01	.69E 00	.91E 00
.038	.29E 00	.52E 00	.55E 00	.63E 00	.83E 00	.28E 00	.22E 00	.75E 00
.039	.55E 00	.56E 00	.43E 00	.50E 00	.19E 00	.61E 00	.93E 00	.15E 00
.040	.50E 00	.66E 00	.49E 00	.93E 00	.23E 00	.99E 00	.04E 00	.11E 00
.041	.14E 00	.83E 00	.73E 00	.93E 00	.97E 00	.44E 00	.93E 00	.64E 00
.042	.47E 00	.59E-01	.17E 00	.49E 00	.39E 00	.95E 00	.21E 00	.72E 00
.043	.48E 00	.35E 00	.79E 00	.60E 00	.49E 00	.52E 00	.67E 00	.38E 00
.044	.18E 00	.70E 00	.60E 00	.29E 00	.29E 00	.15E 00	.33E 00	.59E 00
.045	.57E 00	.12E 00	.60E 00	.53E 00	.77E 00	.85E 00	.17E 00	.36E 00
.046	.64E 00	.60E 00	.79E 00	.34E 00	.94E 00	.61E 00	.20E 00	.70E 00
.047	.41E 00	.14E 00	.16E 00	.71E 00	.80E 00	.43E 00	.42E 00	.60E 00
.048	.86E 00	.74E 00	.72E 00	.64E 00	.34E 00	.32E 00	.82E 00	.65E-01
.049	.10E 01	.41E 00	.47E 00	.13E 00	.58E 00	.27E 00	.41E 00	.90E-01

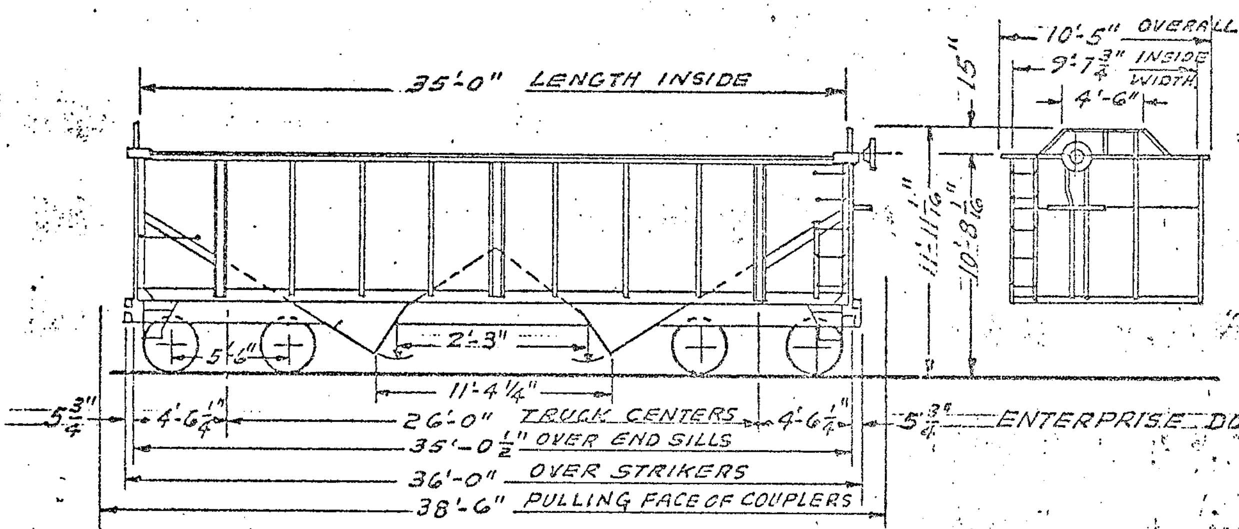

COMPLEX SINE WAVE 5HZ BASE FREQUENCY
VALUE
16.00
8.00
0.00
-8.00
-16.00
-24.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
ARRAY

APPENDIX G

DRAWINGS FOR EQUIPMENT

11

50-TON HOPPER CARS



GENERAL CAR DATA			
Gen. Arrangement	F-17583	Capy. Cu. Ft.	2046
Brake Arrangement	F-17585	With 10" Heap Cu. Ft.	2309
AAR Class	HM	Total Capy. Cu. Ft.	
L&N Equip. Code	202	Ea. End Hopper Cu. Ft.	
Built By	P-S. Lot 8040	Center Hopper Cu. Ft.	
Built or Reblt.	APR. 1952,-FEB. 1953	Floor	
Taken From		Floor Capy.	
Clearance Plate	B	Lining Side or Interior	
Curve Negotiability—with 40'6" car		Lining End	
Average Lt. Wt.	43,800	No. DF Belts	
Average Ld. Lmt.	133,200	No. Lading Anchors	
Center of Gravity		Movable Bulkheads	
Air Brakes	AB-1012	No. Chain Tie Downs	
Brake Regulator		Stake Pockets Per Side	
Hand Brake	MINER, E-17591	Gates or Doors	C-17632
Cushioning		Running Boards	
Coupler	B-E60B-HT	Vibrator Attachment	
Yoke	C-9965	Roof	
Draft Gear	C-13268, E-16558	Removable Cover	
Striker	E-17593	Drop Ends	
Back Stop & C. Filler	E-17594	Coiled Steel Cradles	

50-TON TRUCK DATA	
No. 99 Type S-2A	Side Bearing G56-C, C-16140
Dwg. E-17611 Capy. 5 1/2"x10"	Journals FRICTION BEARING
Wt. 7600# Bowl Dia. 12"	Ped. Adapter
Wheels 33" C-22940	Axles 5 1/2"x10" B-10553
Side Frame FS-4110, F-16656	Brake Beams #18, B-16301
Bolster FS-4158, E-17613	Brake Shoes AAR-1A
Bowl Wear Plate	Trk. Mounted Brakes
Bowl Wear Ring	
Live Lever 7"x14" SH-36968	
Dead Lever 5"x10" SH-37831	
Bottom Rod (THRU) SH-36178	
TRUCK SPRINGS PER TRUCK	MISCELLANEOUS
Outer 10 SH-35480 (D-3)	
Inner 4 SH-35481 (D-3)	
Snubber	
Shock Absorber	
RIDE CONTROL SPRGS. PER TRK.	
Outer	
Inner	
Side 4 SH-36402	
Friction Casting C-16138	

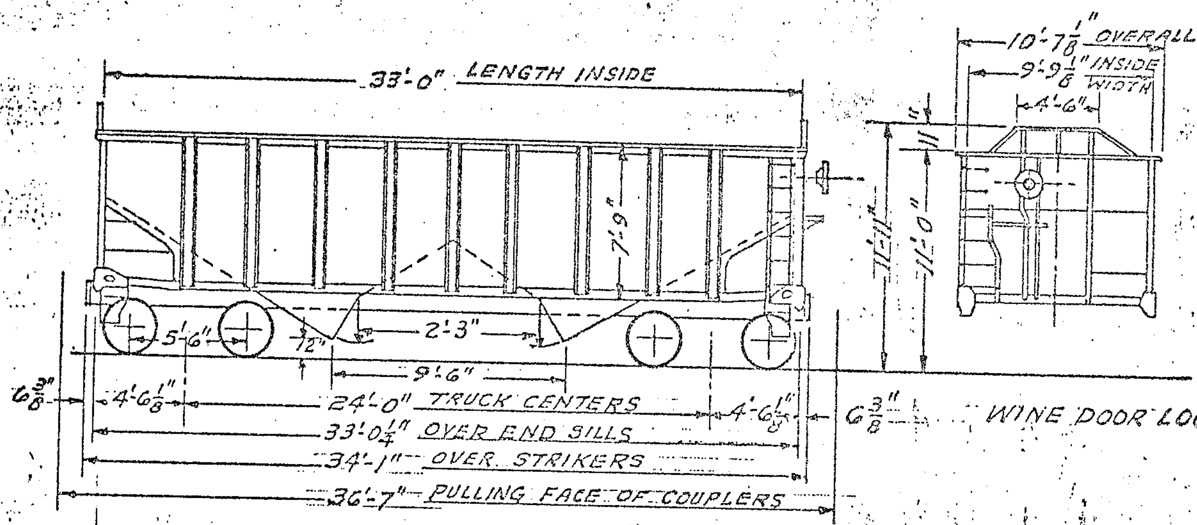
NO. CARS	CAR SERIES
873	84200-85199

L & N R. R. CO.
MECH. ENGINEERS OFFICE
LOUISVILLE, KY.

REVISION

SHEET NO. H-12

11



SERIES	TRUCK.
115500 - 119999 EXCEPT 150 CARS WHICH HAVE TRUCK NO. 75-A.	71-B E-20098
	75-A E-20175

50-TON HOPPER CARS

GENERAL CAR DATA

Gen. Arrangement	F-24199	Capy. Cu. Ft.	2020
Brake Arrangement	F-24203	With 10" Heap Cu. Ft.	2280
AAR Class	HM	Total Capy. Cu. Ft.	
L&N Equip. Code	204	Ea. End Hopper Cu. Ft.	
Built By	Lot JOB 450 434 & 347	Center Hopper Cu. Ft.	
Built or Reblt.	L&N. SO. LOU. 1960-61	Floor	
Taken From	SEE NOTE 1.	Floor Capy.	
Clearance Plate	B	Lining Side or Interior	
Curve Negotiability—with 40'6" car		Lining End	
Average Lt. Wt.	41,000#	No. DF Belts	
Average Ld. Lmt.	136,000#	No. Lading Anchors	
Center of Gravity		Movable Bulkheads	
Air Brakes	AB 10"x12" Q RR. PRIME OR CACO Q.R.V.	No. Chain Tie Downs	
Brake Regulator		Stake Pockets Per Side	
Hand Brake		Gates or Doors	E-23543
Cushioning		Running Boards	
Coupler	B-E60B-HT	Vibrator Attachment	
Yoke		Roof	
Draft Gear		Removable Cover	
Striker	E-14480	Drop Ends	
Back Stop & C. Filler	E-14481	Coiled Steel Cradles	

50-TON TRUCK DATA

No. 71B	Type	Side Bearing	SEE TRK. DWG.
Dwg. E-20098	Capy. 5½"X10"	Journals	FRICTION BEARING
Wt.	Bowl Dia. 12"	Ped. Adapter	
Wheels 33"	C-22940	Axles	5½"X10" B-10553
Side Frame	FS-3938, D-14495	Brake Beams	#18, C-19397
Bolster	FS-3939, D-14496	Brake Shoes	AAR-1A
Bowl Wear Plate		Trk. Mounted Brakes	
Bowl Wear Ring			
Live Lever	8"X16" SH-20684		
Dead Lever	8"X16" SH-20684		
Bottom Rod (UNDER)	SH-20685		
TRUCK SPRINGS PER TRUCK		MISCELLANEOUS	
Outer	SEE TRK. DWG.	1. 60000-68149, 72200-72397	
Inner	" " "	81950-82199, 88800-88994	
Snubber	" " "		
Shock Absorber			
RIDE CONTROL SPRGS. PER TRK.			
Outer	SEE TRK. DWG.		
Inner	" " "		
Side	" " "		
Friction Casting			

NO. CARS	CAR SERIES
4268	115500-119999

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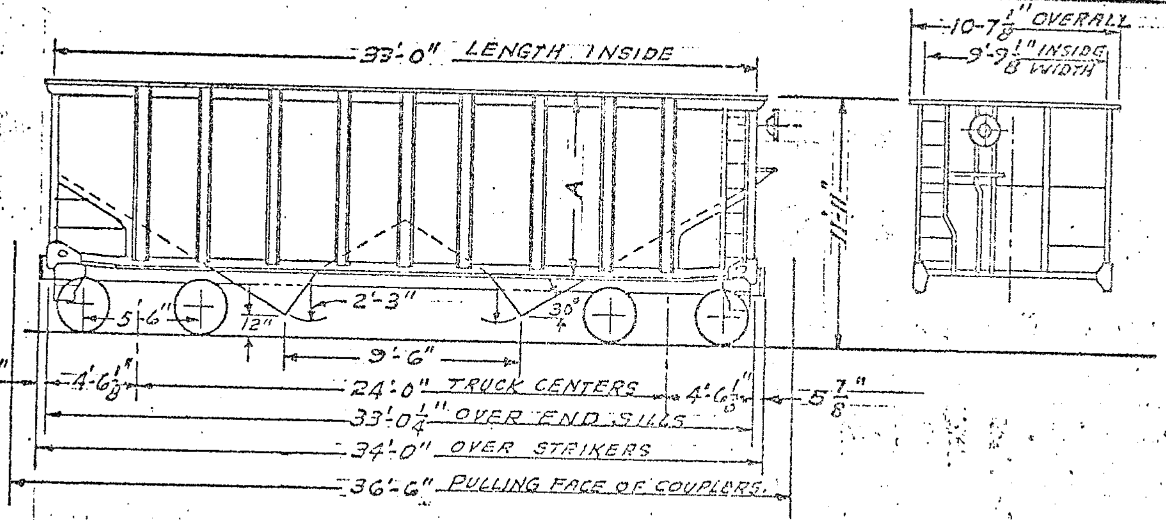
MECH. ENGINEERS OFFICE
LOUISVILLE, KY.

REVISION A

SHEET NO. H-15



SERIES	TRUCK No.	SERIES	DOOR LOCKS
130000-131699 131900-132299	86 D-16238	132300-132499 131100-131299	E-16252 WINE ADJ.
130000-131699 132300-132499	87 E-16401	130000-131099 131300-132299	E-16402 ENTERPRISE
131700-131899	90 D-16600		

60-TON HOPPER CARS

GENERAL CAR DATA

Gen. Arrangement		Capy. Cu. Ft.	2450
Brake Arrangement		With 10" Heap Cu. Ft.	2718
AAR Class	HM	Total Capy. Cu. Ft.	
L&N Equip. Code	210	Ea. End Hopper Cu. Ft.	
Built By	P-S. Lot 717, 718, 807, 808	Center Hopper Cu. Ft.	
Built or Reblt.	L&N 1964 S. LOU.	Floor	
Taken From	32000-33999, 76150-81949	Floor Capy.	
Clearance Plate	B	Lining Side or Interior	
Curve Negotiability–with 40'6" car		Lining End	
Average Lt. Wt.	40,900	No. DF Belts	
Average Ld. Lmt.	136,100	No. Lading Anchors	
Center of Gravity		Movable Bulkheads	
Air Brakes	AB-1012 (CACO)	No. Chain Tie Downs	
Brake Regulator		Stake Pockets Per Side	
Hand Brake	E-16398, E-16472	Gates or Doors	SEE NOTE 2
Cushioning		Running Boards	
Coupler	B-E60B-HT	Vibrator Attachment	
Yoke	C-9965	Roof	
Draft Gear		Removable Cover	
Striker	E-16096, E-16410	Drop Ends	
Back Stop & C. Filler	E-16464, E-16433	Coiled Steel Cradles	

60-TON TRUCK DATA

No. 86, 87, 90 Type S-2A, A-3	Side Bearing C-16140
Dwg. SEE TABLE Capy. 5½" X 10"	Journals FRICTION BEARING
Wt. SEE NOTE 1. Bowl Dia. 12"	Ped. Adapter
Wheels 33" C-22940	Axles 5½" X 10" B-10553
Side Frame SEE TRK. DWG.	Brake Beams #18, B-16301
Bolster " " "	Brake Shoes AAR-1A
Bowl Wear Plate	Trk. Mounted Brakes
Bowl Wear Ring	
Live Lever SEE TRK. DWG.	
Dead Lever " " "	
Bottom Rod (THRU) " " "	
TRUCK SPRINGS PER TRUCK	MISCELLANEOUS
Outer SEE TRK. DWG.	1. #86 WT. – 7640#
Inner " " "	#87 WT. – 7250#
Snubber " " "	#90 WT. – 7840#
Shock Absorber	2. WINE E-23543
RIDE CONTROL SPRGS. PER TRK.	ENTERPRISE E-23773
Outer SEE TRK. DWG.	
Inner " " "	
Side " " "	
Friction Casting	

NO. CARS	CAR SERIES
	130000-131699 DIM. A = 8'-8"
2423	131700-132499 DIM. A = 8'-5 3/4"

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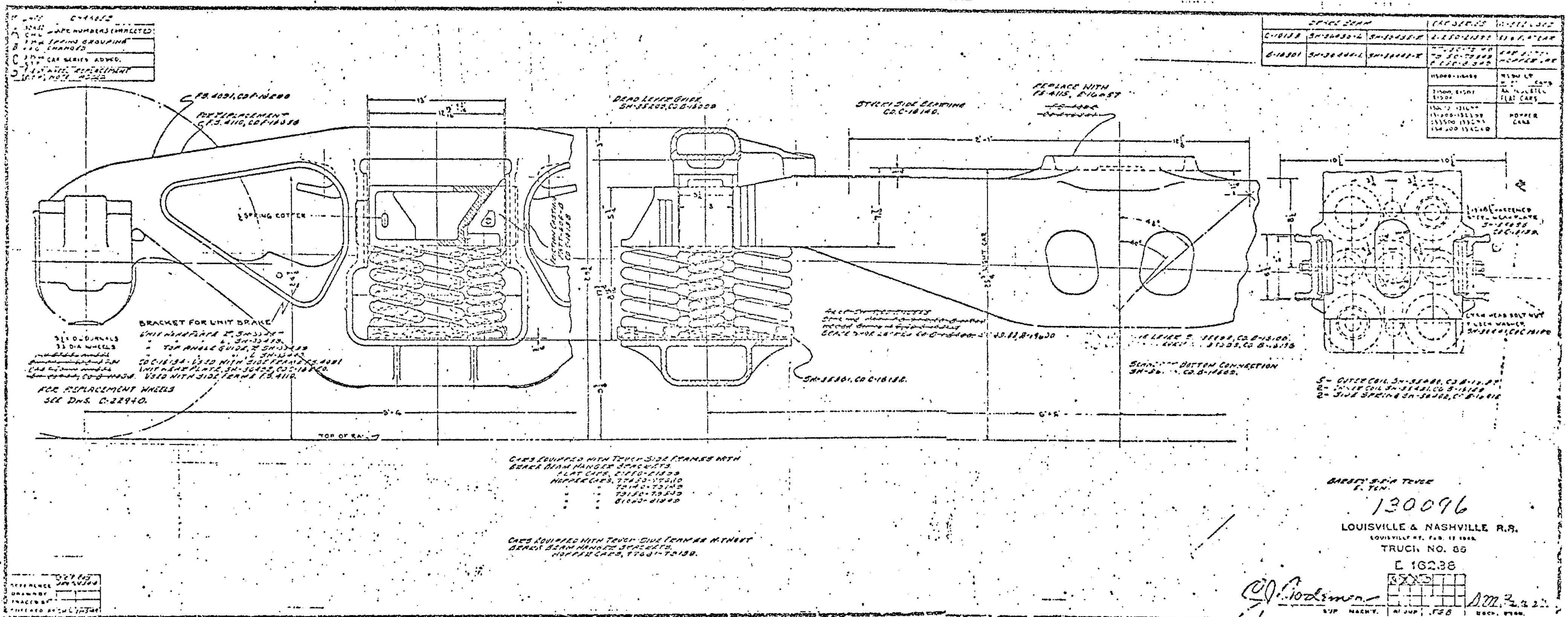
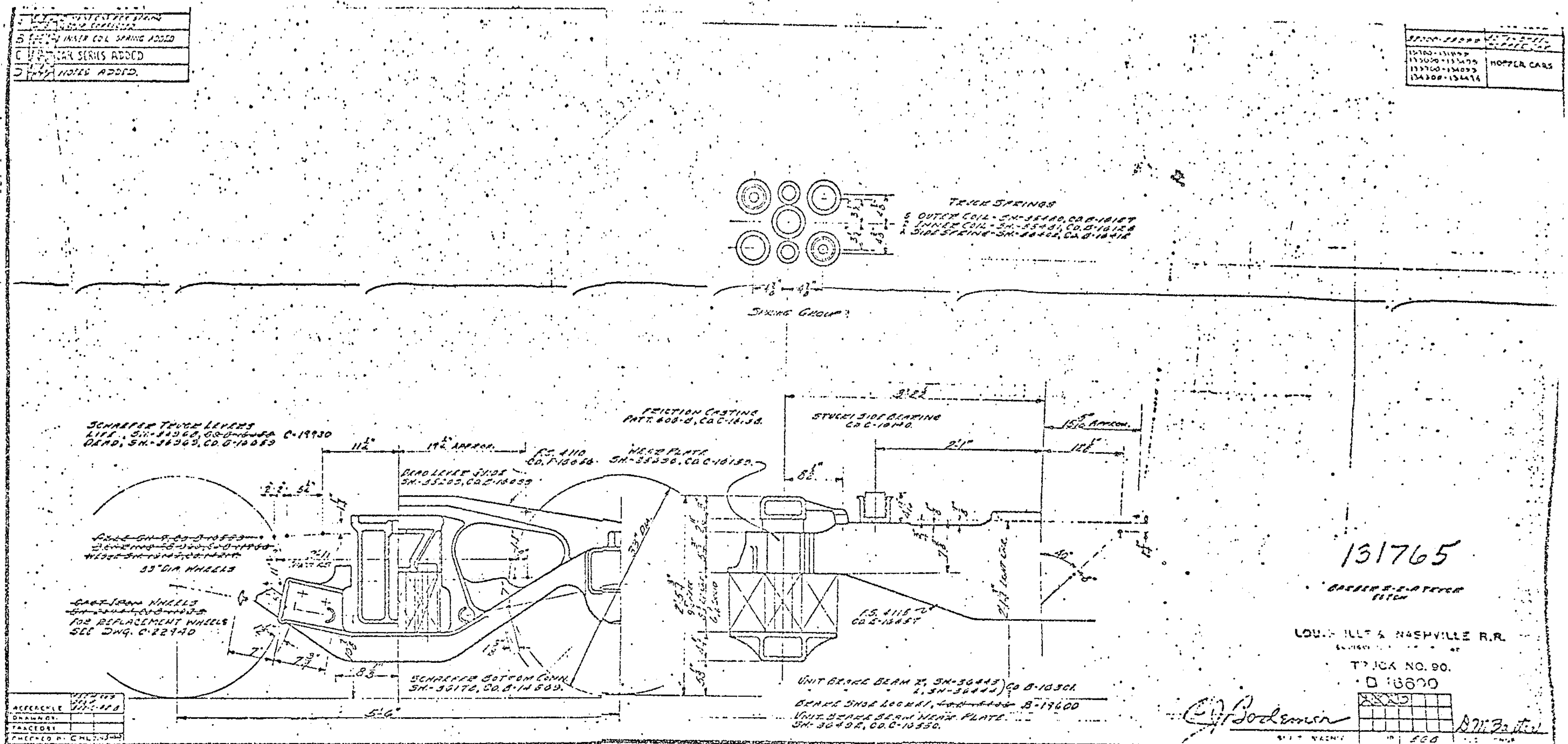
LOUISVILLE, KY.

REVISION

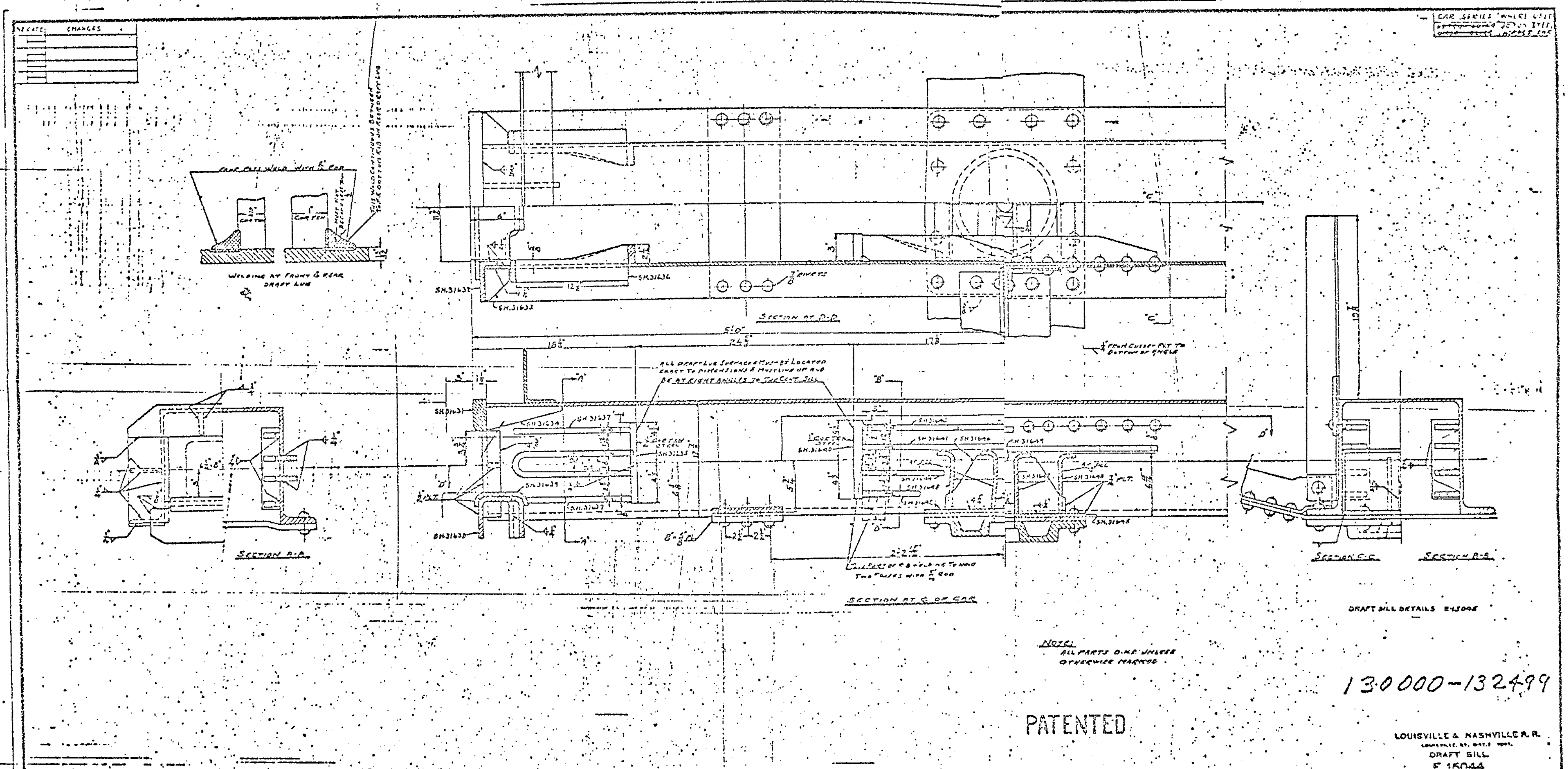
SHEET NO. H-17

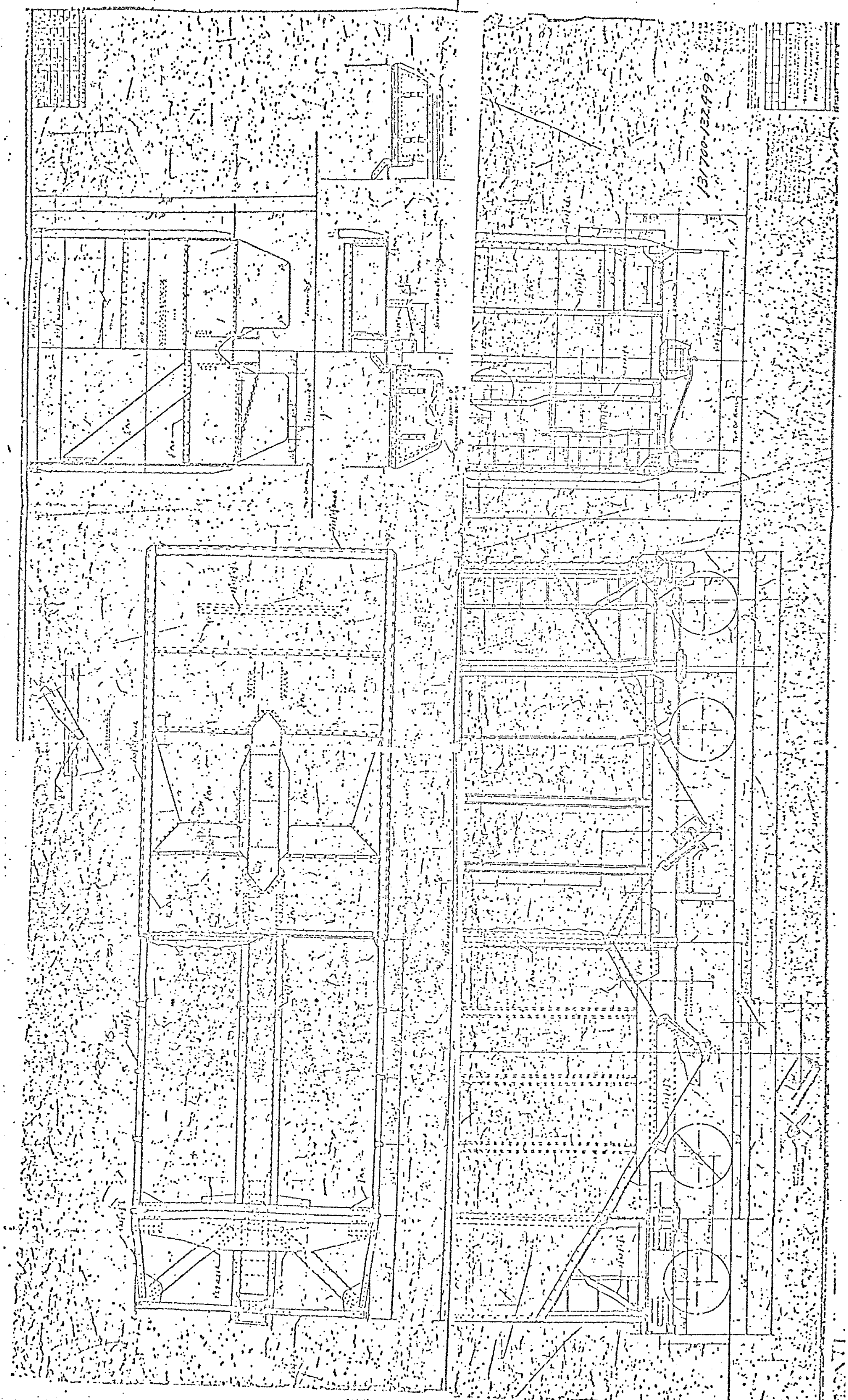


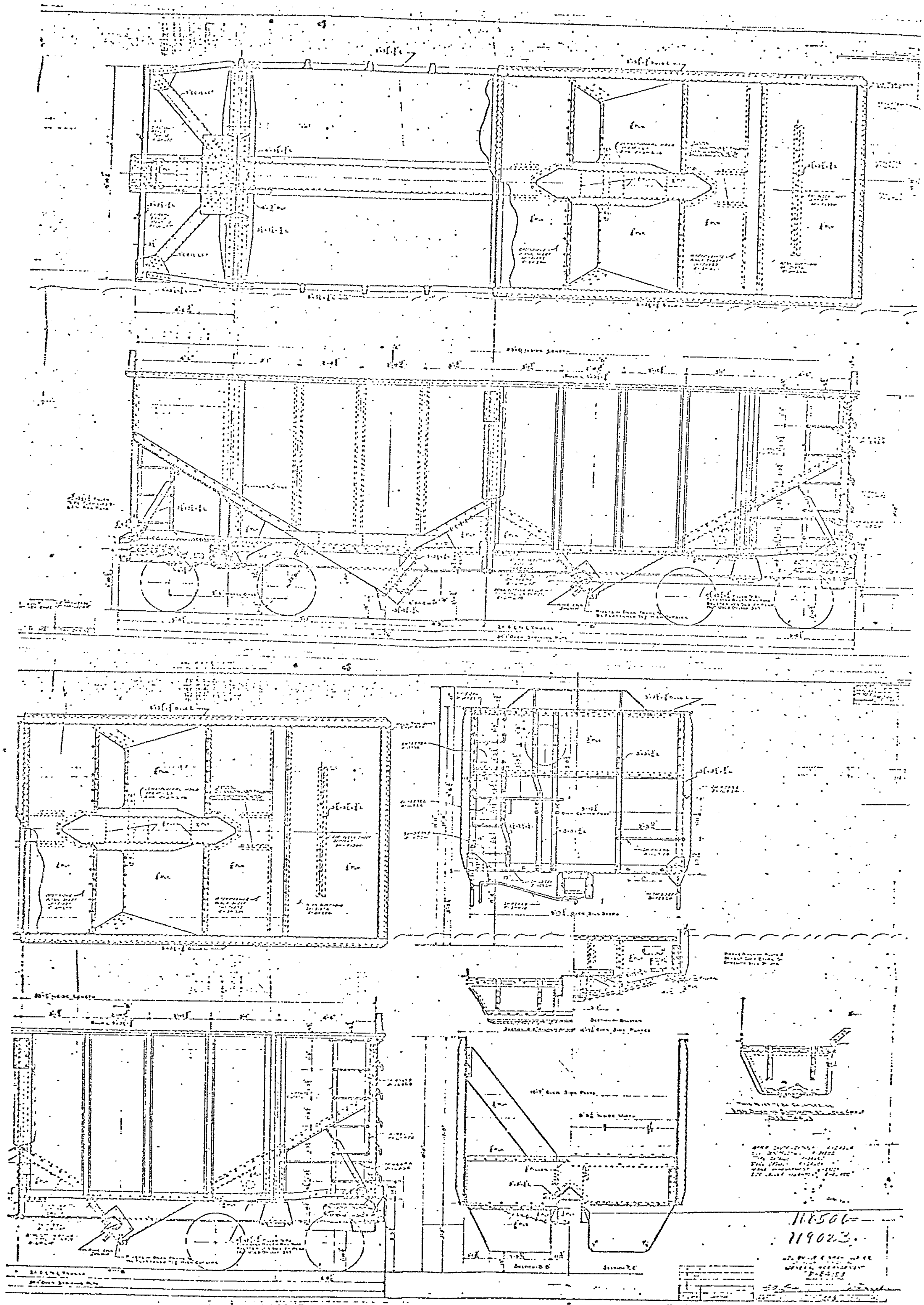
BRACKET FOR UNIT BRAKE
SPRING COTTER
TOP OF RAIL
FOR REPLACEMENT WHEELS
SEE DWG. C-22940.
130096
LOUISVILLE & NASHVILLE R.R.
TRUCK NO. 85
C 16238

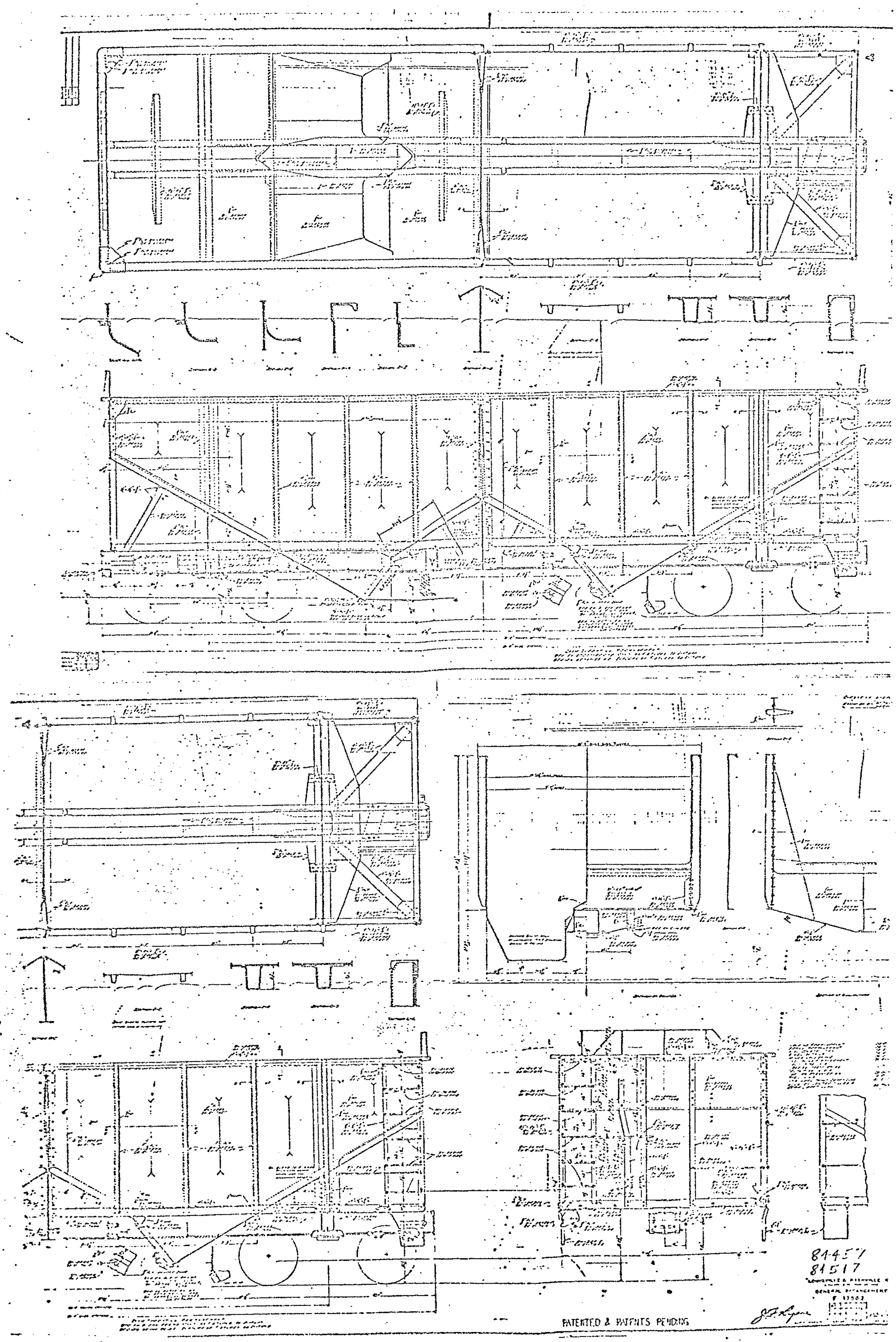


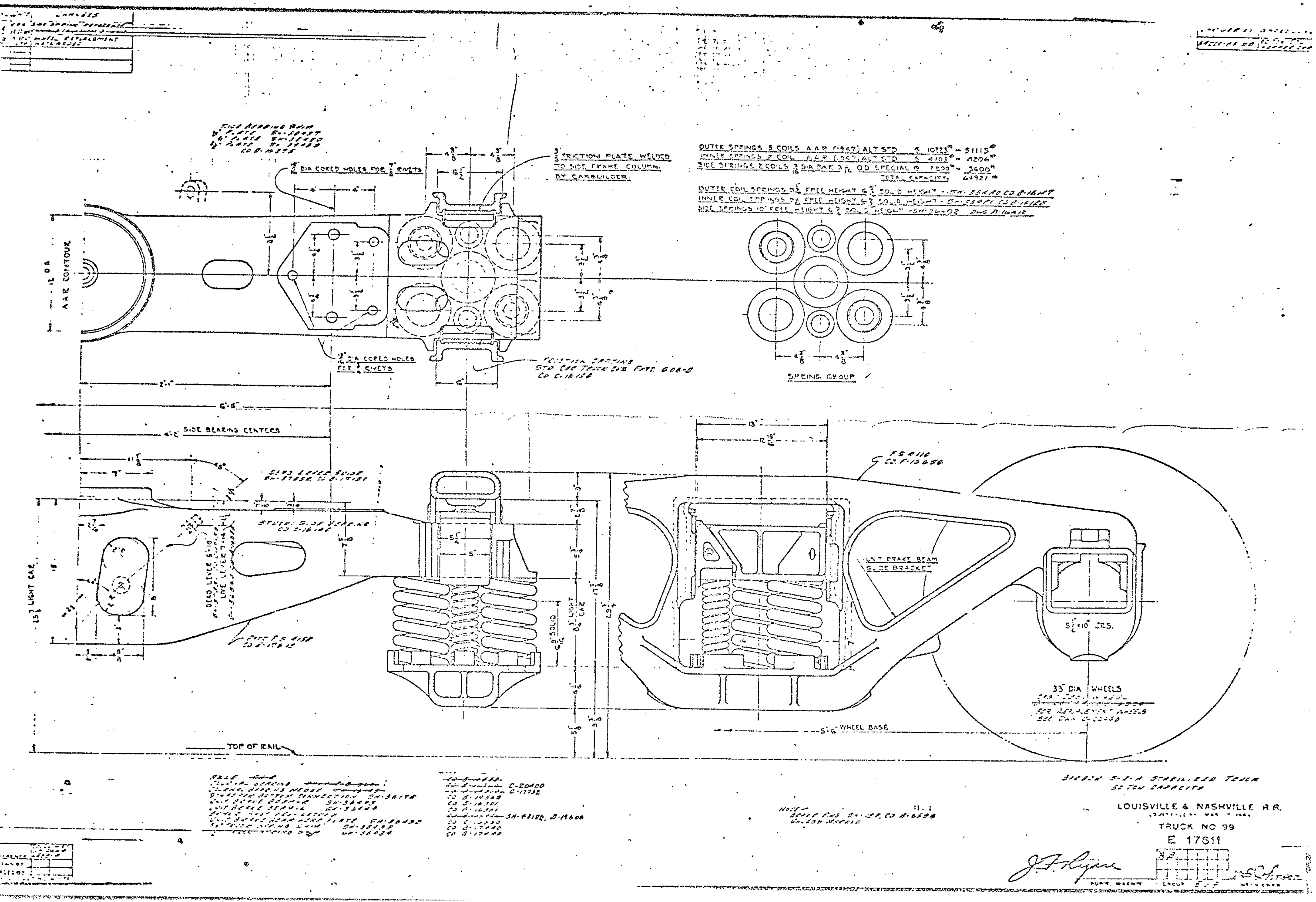
INNER COIL SPRING ADDED
CAR SERIES ADDED
NOTES ADDED.
HOPPER CARS
TRUCK SPRINGS
SPRING GROUP
FRICTION CASTING
STUCKI SIDE BEARING
SCHAEFER TRUCK LEVERS
WEAR PLATE
DEAD LEVER GUIDE
33" DIA. WHEELS
FOR REPLACEMENT WHEELS SEE DWG. C-22940
SCHAEFER BOTTOM CONN.
UNIT BRAKE BEAM
BRAKE SHOE LOCKS
UNIT BRAKE BEAM WEAR PLATE
131765
LOUISVILLE & NASHVILLE R.R.
TRUCK NO. 90.
D 18600


CHANGES
WELDING AT FRONT & REAR DRAFT LUG
SECTION AT D-D
SECTION A-A
SECTION AT ℄ OF CAR
SECTION C-C
SECTION B-B
DRAFT SILL DETAILS
NOTE:
ALL PARTS O.H.S. UNLESS OTHERWISE MARKED
130000-132499
PATENTED
LOUISVILLE & NASHVILLE R.R.
DRAFT SILL
F 15044

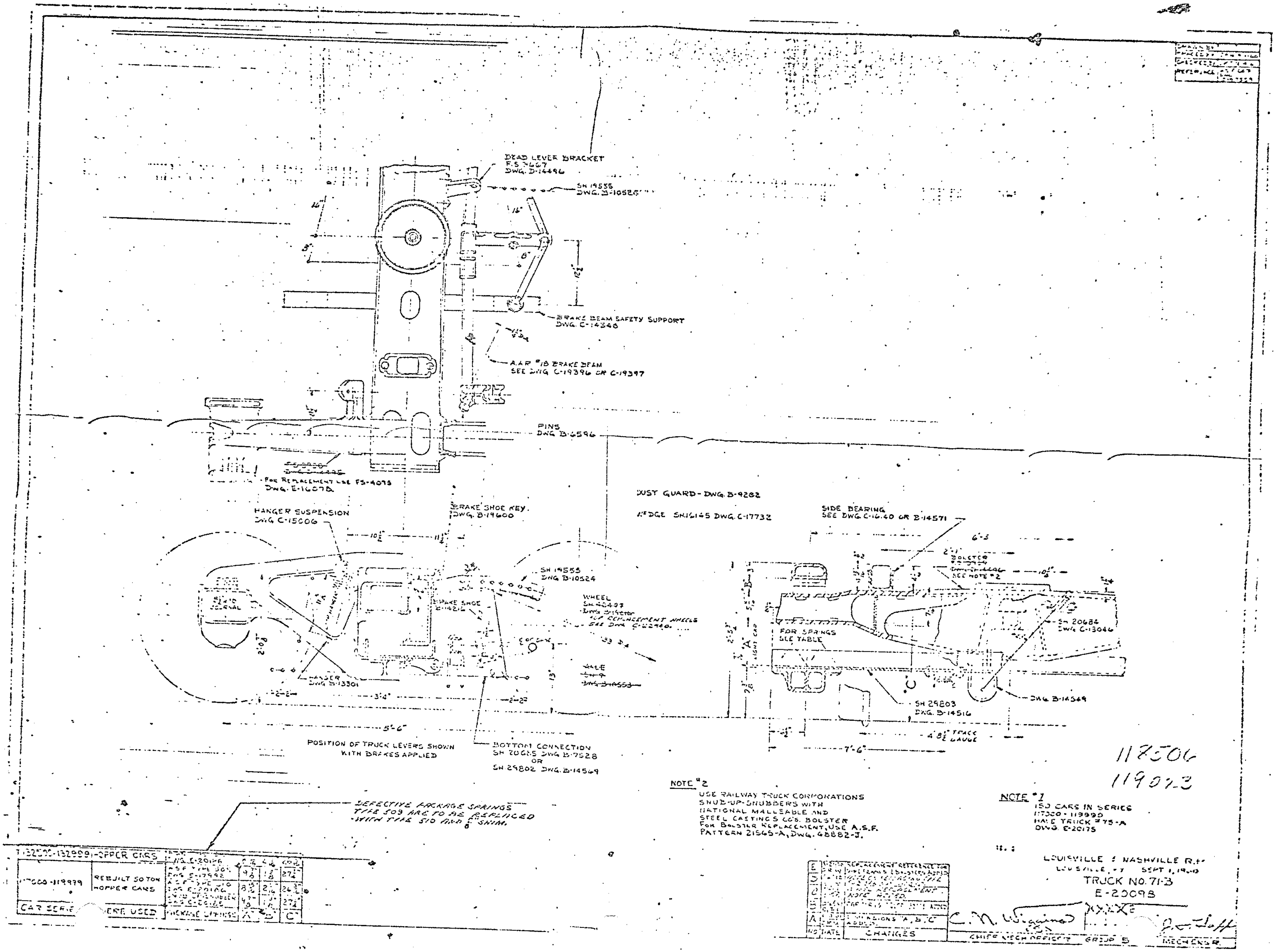

131700-132,999


118506
119023.

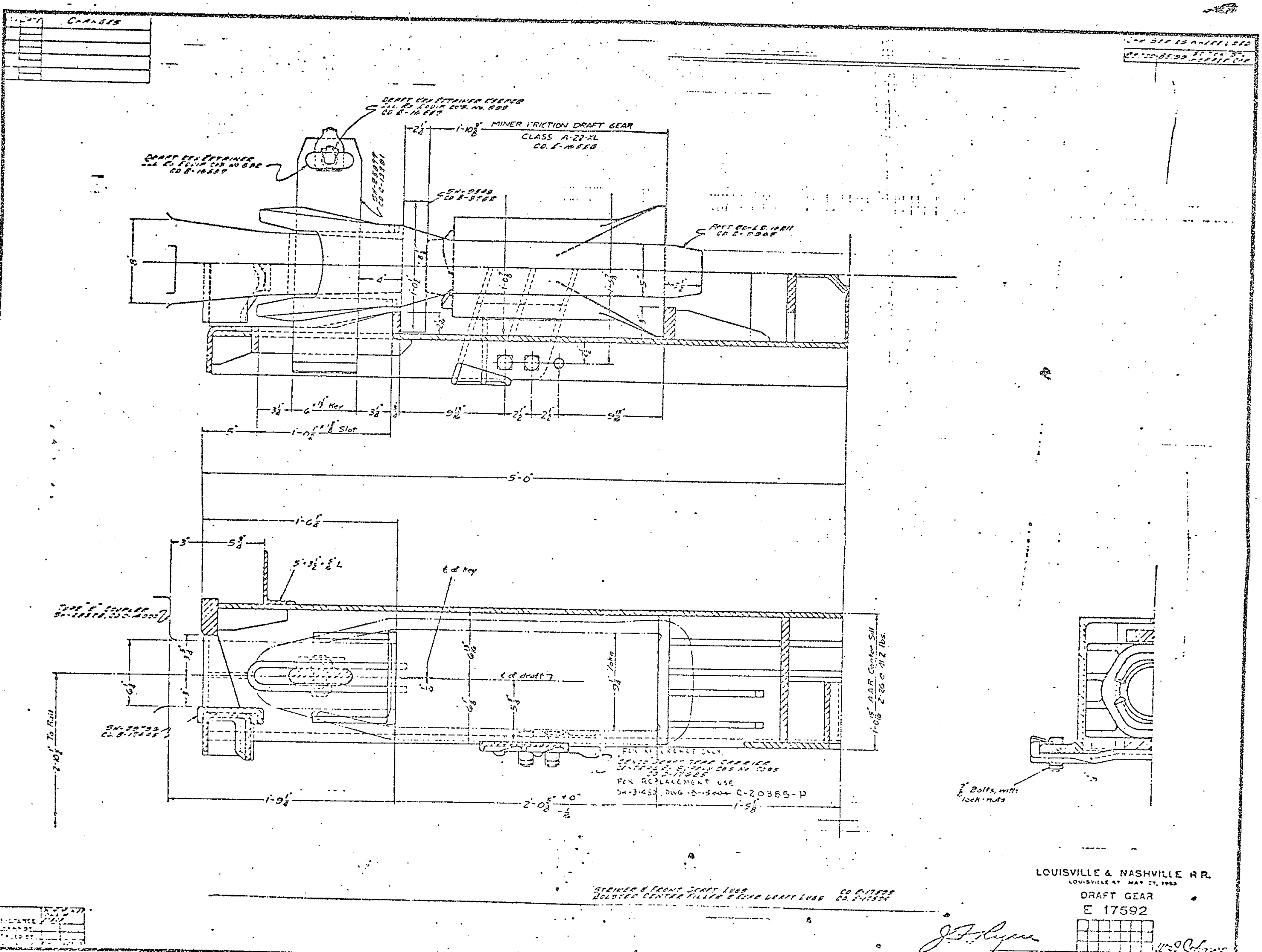

81457
81517
GENERAL ARRANGEMENT
PATENTED & PATENTS PENDING



AAR CONTOUR
12 DIA
$\frac{7}{8}$" DIA CORED HOLES FOR $\frac{7}{8}$" RIVETS
$\frac{7}{8}$" DIA CORED HOLES FOR $\frac{3}{4}$" RIVETS
$\frac{3}{8}$" FRICTION PLATE WELDED TO SIDE FRAME COLUMN, BY CARBUILDER
OUTER SPRINGS 5 COILS A.A.R. (1947) ALT STD 5 10223# = 51115#
INNER SPRINGS 2 COIL A.A.R. (1947) ALT STD 2 4103# = 8206#
SIDE SPRINGS 2 COILS $\frac{3}{16}$ DIA BAR 3$\frac{1}{16}$ OD SPECIAL @ 7800# = 3600#
TOTAL CAPACITY 64921#
SPRING GROUP
SIDE BEARINS CENTERS
TOP OF RAIL
LIGHT CAR
DEAD LEVER 5'-10"
LIVE LEVER 7'-14"
$6\frac{9}{16}$" SOLID
$8\frac{3}{4}$" LIGHT CAR
UNIT BRAKE BEAM GUIDE BRACKET
5'-6" WHEEL BASE
33" DIA WHEELS
FOR REPLACEMENT WHEELS SEE DWG D-12440
$5\frac{1}{2}$" x 10" JRS.
C-20400
C-17732
SH-67180, D-19600
BARBER S-2-A STABILIZED TRUCK
50 TON CAPACITY
LOUISVILLE & NASHVILLE R.R.
TRUCK NO 99
E 17611



DEAD LEVER BRACKET
F.S. 4667
DWG. B-14496
SH 19555
DWG. B-10526
BRAKE BEAM SAFETY SUPPORT
DWG. C-14346
A.A.R. #18 BRAKE BEAM
SEE DWG C-19396 OR C-19397
PINS
DWG B-6596
FOR REPLACEMENT USE FS-4075
DWG. E-16078
HANGER SUSPENSION
DWG C-15006
BRAKE SHOE KEY
DWG. B-19600
DUST GUARD - DWG. B-9282
WEDGE SH16145 DWG. C-17732
SIDE BEARING
SEE DWG C-16140 OR B-14571
SH 19555
DWG B-10524
WHEEL
BRAKE SHOE
FOR SPRINGS
SEE TABLE
SH 20684
DWG C-13046
LIGHT CAR
SH 29803
DWG. B-14516
DWG B-14549
4'-8½" TRACK GAUGE
7'-6"
5'-6"
POSITION OF TRUCK LEVERS SHOWN
WITH BRAKES APPLIED
BOTTOM CONNECTION
SH 20685 DWG B-7528
OR
SH 29802 DWG. B-14569
NOTE #2
USE RAILWAY TRUCK CORPORATIONS
SNUB-UP-SNUBBERS WITH
NATIONAL MALLEABLE AND
STEEL CASTINGS CO'S. BOLSTER
FOR BOLSTER REPLACEMENT, USE A.S.F.
PATTERN 21565-A, DWG. 48882-J.
NOTE #1
150 CARS IN SERIES
117500 - 119990
HAVE TRUCK #75-A
DWG. E-20175
DEFECTIVE PACKAGE SPRINGS
TYPE 509 ARE TO BE REPLACED
WITH TYPE 510 AND ⅛" SHIM.
117500-119999
REBUILT 50 TON HOPPER CARS
CAR SERIES
WHERE USED
PACKAGE SPRINGS
CHANGES
LOUISVILLE & NASHVILLE R.R.
LOUISVILLE, KY. SEPT 1, 1940
TRUCK NO. 71-B
E-20098
CHIEF MECH. OFFICER
MECH. ENGR.
117506
119023



CHANGES
MINER FRICTION DRAFT GEAR
CLASS A-22-XL
5'-0"
1'-6¼"
5·3½·⁵⁄₁₆ L
℄ of key
℄ of draft
9⅛" Yoke
⅞" Bolts, with lock-nuts
FOR REPLACEMENT USE
C-20355-P
15" A.A.R. Center Sill
2'-10½" To Rail
LOUISVILLE & NASHVILLE R.R.
DRAFT GEAR
E 17592

APPENDIX H

IMPORTANT CORRESPONDENCE

INDEX TO APPENDIX H

1. Letter and attachments, dated August 26, 1975, to L. J. Schlink from J. E. Everett, GATX Corporation, regarding spring capacities, specifications and drawings on tank cars.

2. Letter and attachments, dated October 8, 1975, to Ross Gill from C. E. Reedy, RPI-AAR, regarding procedure for pressurization of tank cars to 100 psi. Letter dated October 7, 1975 attached hereto.

3. Letter from L. J. Schlink to R. T. Gill, dated October 6, 1975, regarding followup details of meeting held at Washington University on October 1 and 2, 1975.

4. Letter from L. J. Schlink to Ross Gill, dated October 17, 1975, relative to outages and coupler information.

5. Letter from L. J. Schlink to R. T. Gill, dated October 31, 1975, relative to specifications and drawings for GATX 57688 and GATX 92571 .

R. G. 9/15/75

SEP 15 REC'D

RAILROAD TANK CAR SAFETY RESEARCH AND TEST PROJECT

AN RPI-AAR COOPERATIVE PROGRAM

August 26, 1975

File: G.S. 39.336
PH 15

Mr. L. J. Schlink
Union Tank Car Company
151st Street & Railroad Avenue
East Chicago, Indiana 46312

SUBJECT: ASSIGNMENTS FROM PUEBLO MEETING OF AUGUST 5, 1975

Dear Sir:

1. GATX 92561 is scheduled to ship from our Argentine Shop week of 8-25-75.

2. I have looked into the springing situation for this car. The car as shipped had this spring group for a rail load of 263,000 lbs.

7 outer D3 @ 10223	=	71,561
4 inner D3 @ 4103	=	16,412
2 side coils @ 4499		8,998
Total Group Capacity (Solid)	=	96,971#
Total Truck Capacity	=	193,942
Total Car Capacity	=	387,884

Working capacity is 263/388 - 67% of actual capacity. At rail load, the car is 62% full (of water) by volume. At 75% full (of water) the car weighs 292,000 lbs. This is 29,000 lbs. overweight, therefore, this springing capacity must be added to the car or 29,000/4 = 7250 lbs. per truck. I would, therefore, recommend adding two (2) D3 inner springs per group. SPRING GROUP

			added
7 outer D3 @ 10223	=	71,561	
6 inner D3 @ 4103	=	24,618	8206
2 side coils @ 4499	=	8,998	
Total Group Capacity (Solid)	=	105,177	8206
Total Truck Capacity	=	210,354	16412
Total Car Capacity		420,708	32824

Working capacity is 292/421 = 69% of actual.

(con't)

Reply to J. E. Everett
GATX Corporation
P.O. Box 532
Sharon, Pennsylvania 16146

TO: L. J. Schlink

August 26, 1975

File: G.S. 39.336
PH 15

For the 92% capacity (by volume) the rail load would be 338,300 lbs. or an increase of 75,000 lbs. over the 62% full car. This is 18,750 lbs. per spring group. We can only add one more D3 inner spring and two (2) inner side coils which results in the following:

			added
7 outer D3 @ 10223	=	71,561	
7 inner D3 @ 4103	=	28,721	12309
2 outer side coils @ 4499	=	8,998	
2 inner side coils @ 1738	=	3,475	3475
Total Group Capacity (Solid)	=	112,756	15784
Total Truck Capacity		225,512	31568
Total Car Capacity		451,024	63135

Working capacity is 338/451 = 74% of actual

This results in springing that is 12,000 lbs. under the required amount based on the criteria we are using. This 12,000 lbs. is only 3% of the total load on the car, therefore, not too bad. The only way we can add more capacity is to either purchase special springs or go to D-2 springs which, in my opinion will result in too much of a change in the springing rate. In view of this, it appears the arrangement shown for the 92% outage can be used.

3. As you requested, I am enclosing 15 sets of prints for the orange book which include the test car general arrangement and manway arrangement drawings.

4. Enclosed is our outage table 6895 which covers the test cars GATX 91833 and 92561.

5. Also enclosed are some specification sheets on these cars. The center of gravity above the center plate is marked on these and is 63.7 inches.

Would you please distribute any or all the above to the appropriate people.

Very truly yours,

J. E. Everett

JEE:rm

Enclosures

E. A. Phillips
AS 148.2
PH 15

ENGINEERING SPECIFICATIONS

ORDER NO. R.O.-8202
ENGINEERED BY: AVV/JSP
DATE: 2-8-68

91883

CLASS OF CAR: TCC-112A340-W
TANK CAPACITY: 33,500 Gallon
TYPE OF UNDERFRAME: 98
TYPE OF TRUCKS: 100 Ton S-2-A Truck Mounted Cylinders
TYPE OF AIR BRAKE: "AB" Freight Equipment
INSULATION: None INT. LINING: None
LINE CAR XX, SALE CAR ___, PROTOTYPE ___
CUSTOMER OR LESSEE: Tuloma Gas Products Company
COMMODITY: Anhydrous Ammonia
GENERAL ARRANGEMENT DRAWING: 1068-1068

CG ABOVE CENTER PLATE 63.7"

ENGINEERING SPECIFICATIONS/PART 2

(SHOP INSTRUCTIONS)

SHEET 2

ORDER NO. BO 8202
ENGINEERED BY: AVV/JJP
DATE: 2-8-68

ATTENTION: THE INSTRUCTIONS LISTED ON THIS SHEET SHALL PERTAIN TO AND BE CONSIDERED PART OF THE ORDER NUMBER SHOWN ABOVE. SUBSEQUENT ADDITIONAL SHEETS MAY BE ISSUED TO ADD TO, OR SUPERCEDE PREVIOUS INSTRUCTIONS.

1) TRUCKS: Arrgt. Dwg.: 1000-120-A — Capacity: 100 ton

Bearings: "AP" roller — GATX Stock No. 4-9999-2

Brake Beams: Truck Mounted Assembly — GATX Stock No. 7-1109

Truck Bolster: Barber Stabilized S-2-A — GATX Stock No. 26-9999-1[illegible]

Truck Side Frame: Barber Stabilized S-2-A — GATX Stock No. 20-9999-17

Side Bearings: Single - Stucki #656

Center Pin: One Piece

Wheels: 36" Dia. 1-W, R.S. or C.S. rim treated

2) UNDERFRAME: Arrgt. Dwg.: 1210-43 — Type: 98

Truck Centers: 52'-4-1/2" — Length Over Strikers: 63'-3-1/2"

Draft Sill Assy. Dwg.: 306-335

Draft Gear: Arrgt. Dwg.: 1025-37-C

Coupler: B-E60A-HT

3) TANK — Arrgt. Dwg.: 1184-10-1

ID 119" — I.B.H. 59'-11-1/2"

No. of Rings in Shell: Six (6) — Shell Thickness: 5/8"

Heads: 2:1 ellip. — Thickness: 11/16"

Shell & Head Mat'l: AAR M-128 Gr. "B" F.Q.S.

Location of Tank Attach. Dwg.: 1184-10-1

 12/

ORDER NO. BO 8202
ENGINEERED BY: AVV/JDP
DATE: 2-8-68

[illegible]ITION: THE INSTRUCTIONS LISTED ON THIS SHEET SHALL PERTAIN TO AND BE CONSIDERED PART OF THE ORDER NUMBER SHOWN ABOVE. SUBSEQUENT ADDITIONAL SHEETS MAY BE ISSUED TO ADD TO, OR SUPERCEDE PREVIOUS INSTRUCTIONS.

4) FITTINGS: Arrgt. Dwg.: 1049-538

Manway Dwg.: 1078-146 I.D.: 18"

Safety Valve Dwg.: 1049-538 Release Pressure: 280.5#

Air Connection Dwg.: 1049-538

Bottom Outlet Dwg.: N/A

Stuffing Box Dwg.: N/A

Washout Dwg.: N/A Valve Rod: N/A

Top Unloading Dwg.: 1049-538 Consisting of: (2) 3" angle valves W/3 x 2 reducer and plugs

Eduction pipe arrgt. dwg. 1132-282

Manway bonnet arrangement dwg. 1194-25-B

5) SAFETY APPLIANCES: Ladder Arrgt. Dwg.: 1023-155

End Arrgt. Dwg.: 1181-80

Platform Arrgt. Dwg.: 1051-930 Type: Walkway Grating Type: BK-P16

Safety Railing Arrgt. Dwg.: N/A

Mudguard arrangement dwg.: 1107-143

6) AIRBRAKE: Arrgt. Dwg.: 1052-243

Description: Reconditioned brake equipment

Airbrake Equipment Support Location Dwg.: 1181-78-1

Train Line and Cylinder Line Arrangement Dwg.: 1052-240-A

Brake Shoes: Composition

7) HANDBRAKE: Arrgt. Dwg.: 1055-90-F

Description: Vertical Type W/#66 bell crank.

GATX ENGINEERING SPECIFICATIONS/PART I

ORDER NO. BO 8418
ENGINEERED BY: AVV/RF
DATE: 9-12-68

92561

ASS OF CAR: ICC-112A340W
NK CAPACITY: 33,500 Gallons
PE OF UNDERFRAME: 98 U/F
PE OF TRUCKS: 100 Ton S-2-A Truck Mounted Cylinders
PE OF AIR BRAKE: "AB" Freight Equipment
SULATION: None INT. LINING None
SE CAR x , SALE CAR ___, PROTOTYPE ___
STOMER OR LESSEE: GATX - Shell Oil Co.
MMODITY: Liquified Petroleum Gas
NERAL ARRANGEMENT DRAWING: 1058-1068-A

CG ABOVE CENTER R 63.7"

ENGINEERING SPECIFICATIONS/PART 2

(SHOP INSTRUCTIONS)
SHEET #2

12/0

ORDER NO. BO 8418
ENGINEERED BY: AVV/RF
DATE: 9-12-68

ATTENTION: THE INSTRUCTIONS LISTED ON THIS SHEET SHALL PERTAIN TO AND BE CONSIDERED PART OF THE ORDER NUMBER SHOWN ABOVE. SUBSEQUENT ADDITIONAL SHEETS MAY BE ISSUED TO ADD TO, OR SUPERCEDE PREVIOUS INSTRUCTIONS.

1) TRUCKS: Arrgt. Dwg.: 1000-120-B — Capacity: 100 Ton

Bearings: "AP" Roller — GATX Stock No. 4-9999-2

Brake Beams: Truck Mounted Assembly — GATX Stock No. 7-1109

Truck Bolster: Barber Stabilized S-2-A — GATX Stock No. 26-9999-138

Truck Side Frame: Barber Stabilized S-2-A — GATX Stock No. 20-9999-178

Side Bearings: Single, Stucki #656

Center Pin: One Piece

Wheels: 36" Dia. 1-W, R.S. or C.S. Rim Treated

2) UNDERFRAME: Arrgt. Dwg.: 1210-65-A — Type: #98

Truck Centers: 52" - 4-1/2" — Length Over Strikers: 63'-3-1/2"

Draft Sill Assy. Dwg.: 306-361

Draft Gear: Arrg't Dwg. 1025-37-C

Coupler: B-E60A-HT

3) TANK — Arrgt. Dwg.: 1184-10-1-A

ID 119" — I.B.H. 59' - 11'-1/2"

No. of Rings in Shell: Six (6) — Shell Thickness: 5/8"

Heads: 2:1 Ellips. — Thickness: 11/16"

Shell & Head Mat'l: AAR M-128, Gr. "B" - F.Q.S.

Location of Tank Attach. Dwg.: 1184-10-1-A

ENGINEERING SPECIFICATIONS/PART 2

(SHOP INSTRUCTIONS)

SHEET #3

ORDER NO. BO 8418
ENGINEERED BY: AVV/RF
DATE: 9-12-68

TION: THE INSTRUCTIONS LISTED ON THIS SHEET SHALL PERTAIN TO AND BE CONSIDERED PART OF THE ORDER NUMBER SHOWN ABOVE. SUBSEQUENT ADDITIONAL SHEETS MAY BE ISSUED TO ADD TO, OR SUPERCEDE PREVIOUS INSTRUCTIONS.

4) FITTINGS: Arrgt. Dwg.: 1049-538-B

Manway Dwg.: 1078-146-A I.D.: 18"

Safety Valve or Vent Dwg.: 1049-538-B Release Pressure: 280.5#

Air Connection Dwg.: 1049-538-B

Bottom Outlet Dwg.: N/A

Stuffing Box Dwg.: N/A

Washout Dwg.: N/A Valve Rod: N/A

Top Unloading Dwg.: 1049-538-B Consisting of: (3) - 3" Angle Valves with 3" x 2" Reducer & Plugs. (2) - 3" Discharge Pipes.

Eduction Pipe Arrg't Dwg. 1132-240-A

Manway Bonnet Arrg't Dwg. 1194-25-D

5) SAFETY APPLIANCES: Ladder Arrgt. Dwg.: 1023-155

End Arrgt. Dwg.: 1181-80

Platform Arrgt. Dwg.: 1051-930-A Type: Grating Type: BK-P-16

Safety Railing Arrgt. Dwg.: N/A

Mudguard Arrg't Dwg.: 1107-143

6) AIRBRAKE: Arrgt. Dwg.: 1052-243

Description: Reconditioned Brake Equipment

Airbrake Equipment Support Location Dwg.: 1181-78-1

Train Line and Cylinder Line Arrangement Dwg.: 1052-240-A

Brake Shoes: Composition

7) HANDBRAKE: Arrgt. Dwg.: 1055-90-H

Description: Vertical Type with #66 Bell Crank

OUTAGE TABLE NO. 6895

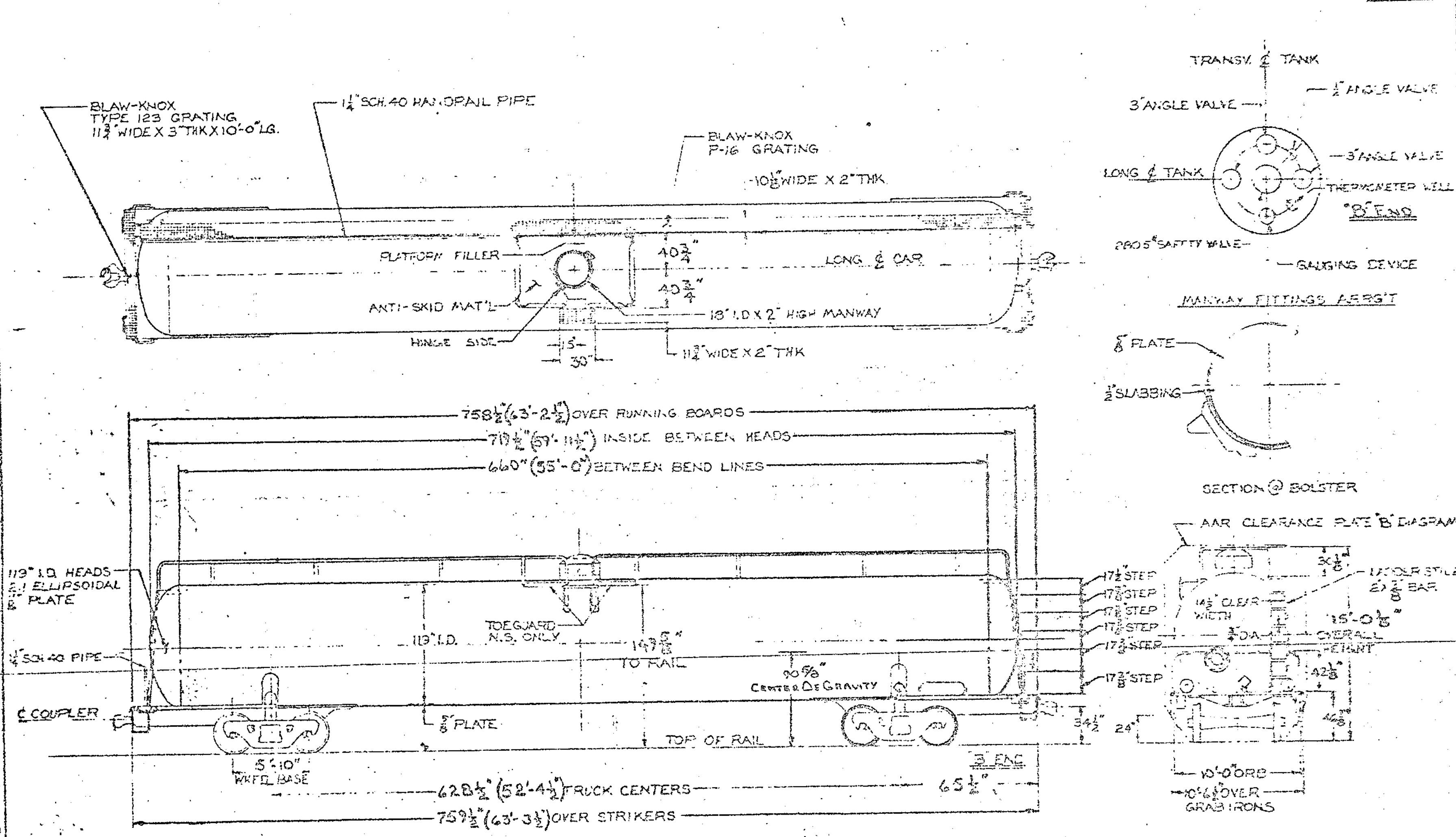
GALLONS PER INCH IN MANWAY 1.10

INS	GALS	INS	GALS	INS	GALS	INS	GALS	INS	GALS	INS	GALS
0	3	10	1320	20	3666	30	6585	40	9873	50	13388
1/4	8		1369		3733		6663		9959		13478
1/2	18		1419		3800		6742		10045		13568
3/4	30		1470		3868		6820		10131		13658
1	45	11	1521	21	3936	31	6900	41	10217	51	13740
1/4	61		1572		4005		6979		10303		13830
1/2	80		1624		4073		7058		10389		13920
3/4	100		1677		4142		7138		10476		14010
2	121	12	1730	22	4212	32	7218	42	10562	52	14100
1/4	144		1783		4281		7298		10649		14190
1/2	169		1837		4352		7378		10736		14280
3/4	194		1892		4422		7459		10823		14370
3	221	13	1947	23	4492	33	7540	43	10910	53	14469
1/4	248		2002		4563		7621		10997		14559
1/2	277		2058		4635		7702		11084		14690
3/4	307		2115		4706		7783		11172		14740
4	338	14	2172	24	4778	34	7865	44	11259	54	14830
1/4	370		2229		4850		7946		11347		15012
1/2	403		2287		4923		8028		11435	55	15193
3/4	436		2346		4995		8110		11523		15376
5	471	15	2404	25	5069	35	8193	45	11610	56	15556
1/4	506		2464		5142		8275		11699		15737
1/2	543		2523		5215		8358		11787	57	15920
3/4	580		2583		5289		8440		11875		16100
6	618	16	2644	26	5363	36	8523	46	11963	58	16282
1/4	656		2705		5438		8607		12052		16464
1/2	696		2766		5512		8690		12140	59	16646
3/4	736		2828		5587		8773		12229		16828
7	777	17	2890	27	5663	37	8857	47	12318	60	17010
1/4	819		2953		5738		8941		12406		17191
1/2	861		3016		5814		9025		12495	61	17373
3/4	904		3079		5890		9109		12584		17555
8	948	18	3143	28	5966	38	9193	48	12673	62	17737
1/4	992		3207		6043		9278		12762		17920
1/2	1037		3271		6119		9362		12852	63	18100
3/4	1083		3336		6196		9447		12941		18281
9	1129	19	3401	29	6273	39	9532	49	13030	64	18463
1/4	1176		3467		6351		9617		13120	119**	33693
1/2	1223		3533		6429		9703		13209	EMPTY	
3/4	1272		3599		6506		9788		13299		

ZERO INCHES REPRESENTS MANWAY NOZZLE CAPACITY
** REPRESENTS SHELL CAP. PLUS MANWAY CAPACITY

GATX 92930
91833
92561

SO 3320



SPECIFICATIONS:

NOMINAL CAPACITY	33,500 GALLONS
EST. LT. WT.	83,300 LBS.
RAIL LOAD	263,000 LBS.
TRUCKS	100 TON BARBER S2A STABILIZED WITH AAR STANDARD ROLLER BEARINGS WITH ALEMITE FITTINGS
WHEELS	36" DIA. ONE (1) WEAR ROLLED STEEL OR ONE (1) WEAR CAST STEEL RIM TREATED
AIR BRAKES	8½ INCH DIA. TRUCK MOUNTED CYLINDERS WITH COMPOSITION SHOES
HANDBRAKE	VERTICAL WHEEL TYPE
DRAFT GEAR	AAR HIGH CAPACITY
COUPLER	AAR S-E60A-HT
YOKE	AAR S-Y40 (24-5/8" GEAR POCKET)
HANDRAILS	1-5/8" SCH 40 PIPE
TANK SHELL	119" I.D., 5/8" PLATE THK. AAR M-128 GRADE B FLANGE QUALITY STEEL (DESIGNED FOR WELD JOINT EFFICIENCY OF 1.0)
TANK HEAD	11/16" NOMINAL THK. 2:1 ELLIPSOIDAL AAR M-128 GRADE "B" FLANGE QUALITY STEEL (DESIGNED FOR WELD JOINT EFFICIENCY OF 1.0)
GRATING	WALKWAY-BLAW KNOX P-16; END RUNNING BOARD: BLAW KNOX #123
END LADDERS	TWO (2)

MINIMUM HORIZONTAL CURVE NEGOTIABILITY

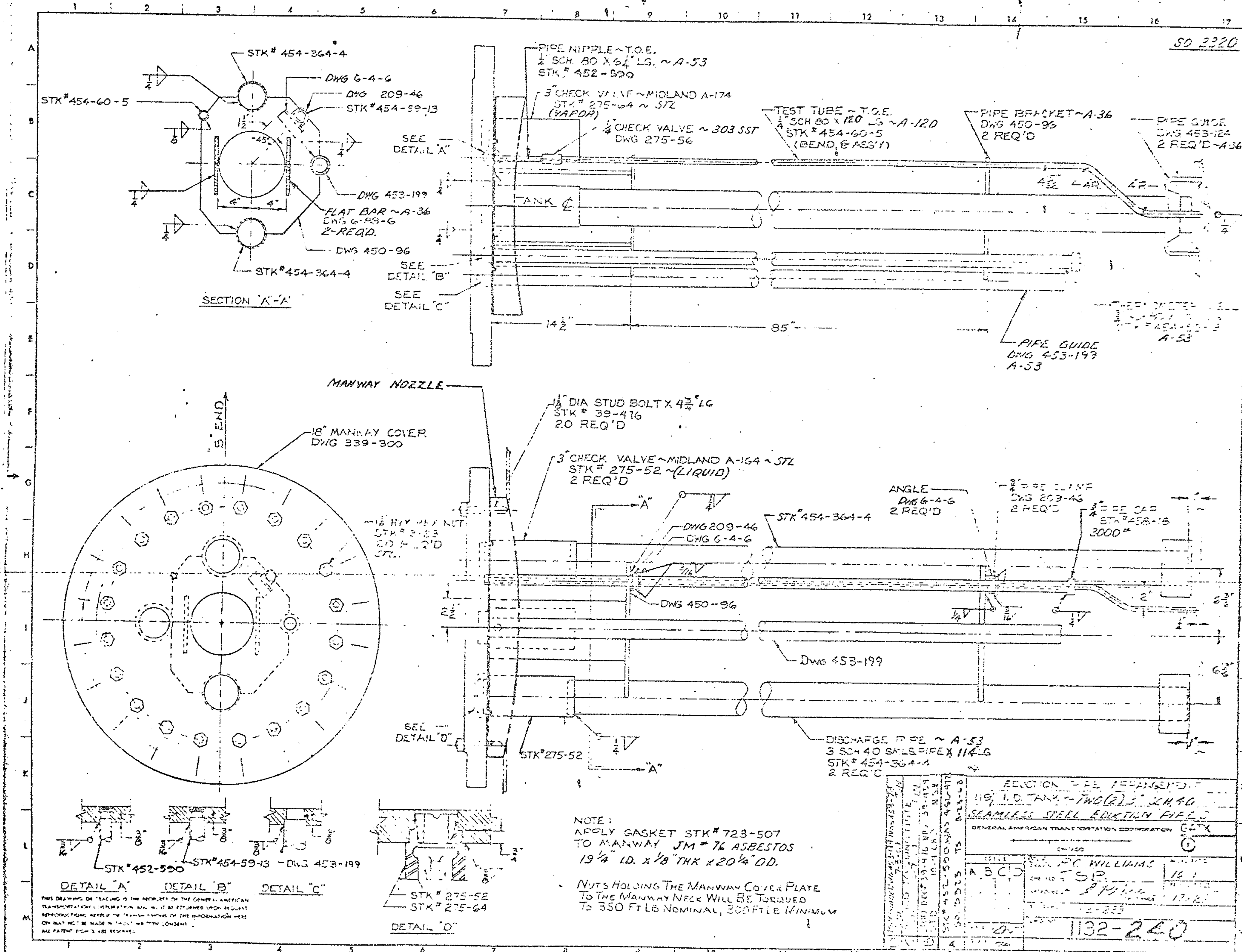
1. TWO LIKE CARS COUPLED TOGETHER.............. 246'
2. TANK CAR ON CURVE - STANDARD CAR ON TANGENT.. 243'

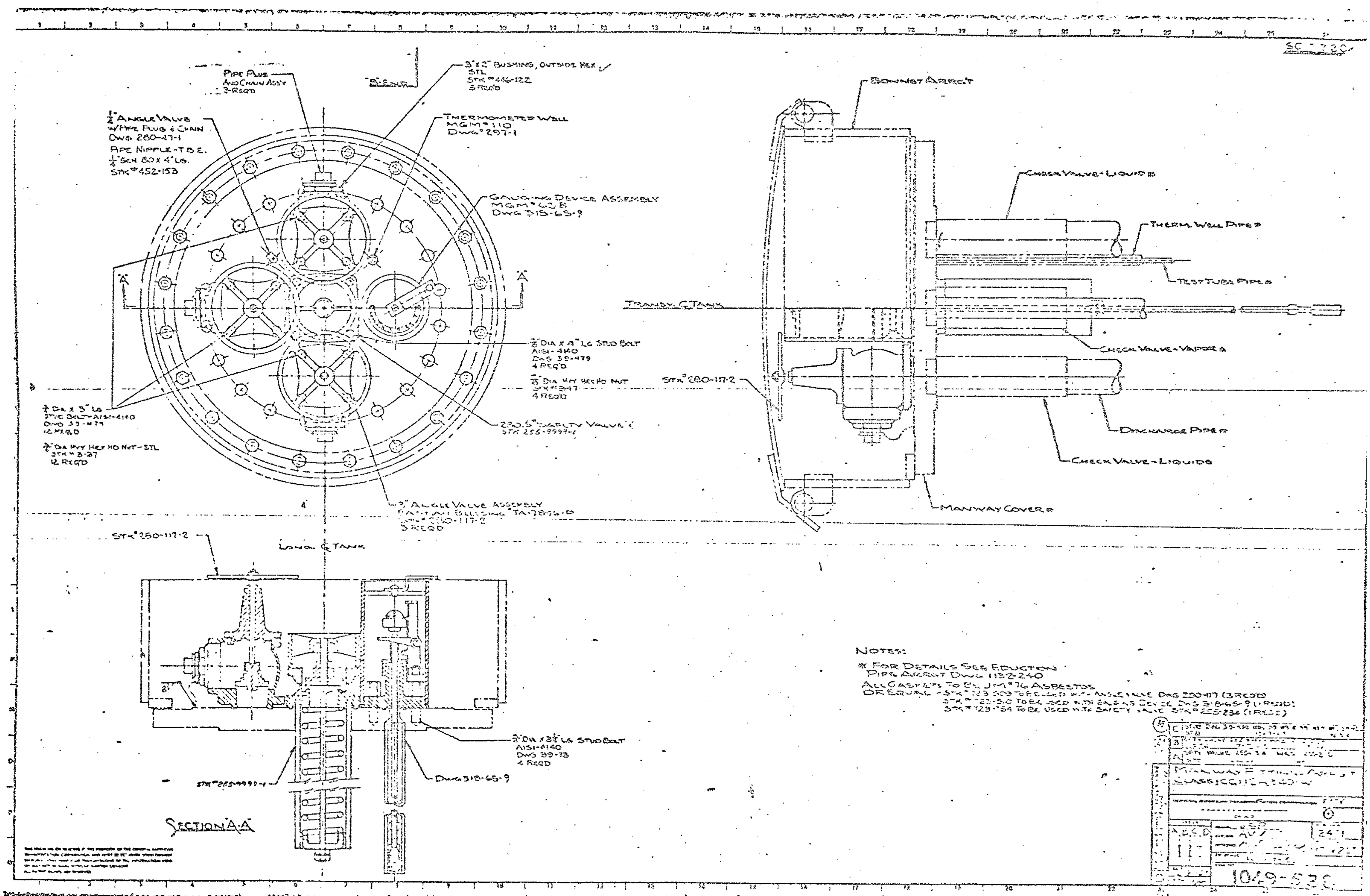
A	RELOCATED HINGE ON MANWAY BONNET S.O. 3320 RF 1-30-65

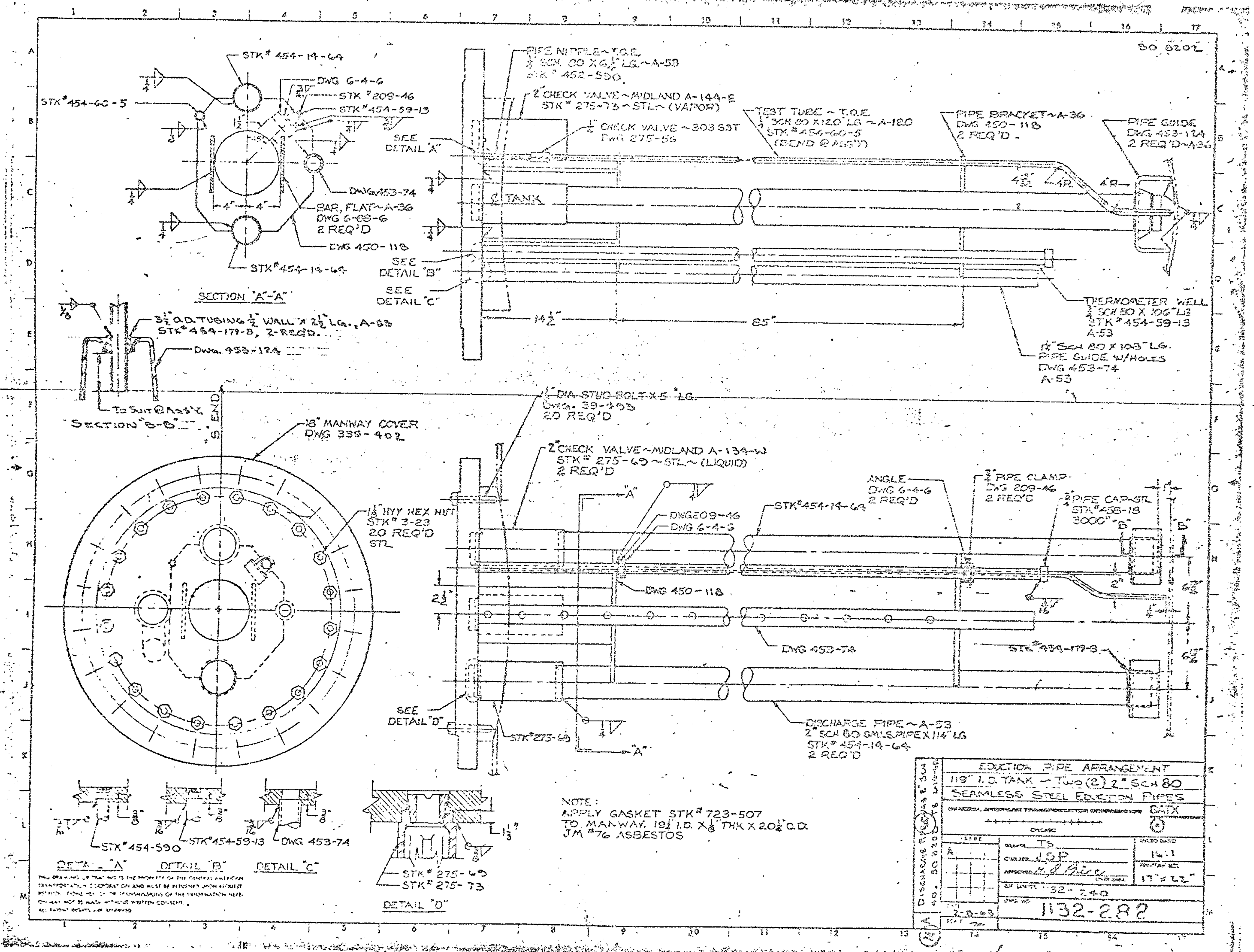
GENERAL ARRANGEMENT
33,500 GALLONS CAR — 98 I/F
100 11/A340-W 119" I.D. TANK 100 TON TRS

GENERAL AMERICAN TRANSPORTATION CORPORATION — CHICAGO — GATX

ISSUE: A
DRAWN: JSO
CHECKED: TS
SCALE: 1/2" = 1'
12-13-67
17" x 22"
REF. DWGS: 10.51
DWG. NO. 1058-1068


SO 3320
STK# 454-364-4
DWG 6-4-6
DWG 209-46
STK# 454-60-5
STK# 454-59-13
DWG 453-199
FLAT BAR ~ A-36
DWG 6-88-6
2-REQ'D.
DWG 450-96
STK# 454-364-4
SECTION "A"-"A"
PIPE NIPPLE ~ T.O.E.
1/2" SCH. 80 X 6 1/4" LG. ~ A-53
STK# 452-590
3" CHECK VALVE ~ MIDLAND A-174
STK# 275-64 ~ STL
(VAPOR)
1/4" CHECK VALVE ~ 303 SST
DWG 275-56
TEST TUBE ~ T.O.E.
1/4" SCH 80 x 120 LG ~ A-120
STK # 454-60-5
(BEND & ASS'Y)
PIPE BRACKET ~ A-36
DWG 450-96
2 REQ'D
PIPE GUIDE
DWG 453-124
2 REQ'D ~ A-36
SEE DETAIL "A"
SEE DETAIL "B"
SEE DETAIL "C"
TANK ℄
14 1/2"
85"
PIPE GUIDE
DWG 453-199
A-53
MANWAY NOZZLE
1 1/8" DIA STUD BOLT X 4 3/4" LG
STK # 39-476
20 REQ'D
18" MANWAY COVER
DWG 339-300
"S" END
3" CHECK VALVE ~ MIDLAND A-164 ~ STL
STK# 275-52 ~ (LIQUID)
2 REQ'D
"A"
DWG 209-46
DWG 6-4-6
STK# 454-364-4
ANGLE
DWG 6-4-6
2 REQ'D
3/4" PIPE CLAMP
DWG 209-46
2 REQ'D
3/4" PIPE CAP
STK# 458-16
3000#
DWG 450-96
DWG 453-199
2 1/2"
2"
6 3/8"
SEE DETAIL "D"
STK# 275-52
"A"
DISCHARGE PIPE ~ A-53
3 SCH 40 SMLS PIPE X 114 LG
STK# 454-364-4
2 REQ'D
STK# 452-590
STK# 454-59-13
DWG 453-199
DETAIL "A"
DETAIL "B"
DETAIL "C"
STK# 275-52
STK# 275-64
DETAIL "D"
NOTE:
APPLY GASKET STK# 723-507
TO MANWAY JM # 76 ASBESTOS
19 1/4" I.D. x 1/8" THK x 20 1/4" O.D.
NUTS HOLDING THE MANWAY COVER PLATE
TO THE MANWAY NECK WILL BE TORQUED
TO 350 FT LB NOMINAL, 300 FT LB MINIMUM
EDUCTION PIPE ARRANGEMENT
SEAMLESS STEEL EDUCTION PIPES
GENERAL AMERICAN TRANSPORTATION CORPORATION
CHICAGO
A.B.C.D.
R.C. WILLIAMS
1132-240


SC-720
Pipe Plug And Chain Ass'y 3-Req'd
3"x2" Bushing, Outside Hex STL STK #446-122 3 Req'd
1/4" Angle Valve W/Pipe Plug & Chain Dwg. 280-47-1
Pipe Nipple-T.B.E. 1/4" Sch 80 x 4" Lg. STK #452-153
Thermometer Well MGM #110 Dwg #297-1
Gauging Device Assembly MGM #C.B Dwg 318-65-9
A
A
3/4" Dia x 4" Lg Stud Bolt AISI-4140 Dwg 39-479 4 Req'd
3/4" Dia Hvy Hex Hd Nut STK #3-47 4 Req'd
3/4" Dia x 3" Lg Stud Bolt-AISI-4140 Dwg 39-479 12 Req'd
3/4" Dia Hvy Hex Hd Nut-STL STK #3-27 12 Req'd
250.5" Safety Valve STK 255-9999-1
2" Angle Valve Assembly STK #280-117-2 3 Req'd
Bonnet Arrg't
Check Valve-Liquid
Therm. Well Pipe
Test Tube Pipe
Transv. ℄ Tank
Check Valve-Vapor
STK #280-117-2
Discharge Pipe
Check Valve-Liquid
Manway Cover
STK #280-117-2
Long ℄ Tank
STK #255-9999-1
3/4" Dia x 3 3/4" Lg Stud Bolt AISI-4140 Dwg 39-78 4 Req'd
Dwg 318-65-9
Section "A-A"
Notes:
* For Details See Eduction Pipe Arrg't Dwg 1132-240
All Gaskets To Be J.M. #76 Asbestos Or Equal - STK #723-509 To Be Used With Angle Valve Dwg 280-117 (3 Req'd)
STK #723-510 To Be Used With Gauging Device Dwg 318-65-9 (1 Req'd)
STK #723-54 To Be Used With Safety Valve STK #255-234 (1 Req'd)
Manway Fitting Arrg't
1049-530



30 8202
STK# 454-14-64
DWG 6-4-6
STK #209-46
STK #454-59-13
STK# 454-60-5
DWG 453-74
BAR, FLAT~A-36
DWG 6-88-6
2 REQ'D
DWG 450-118
STK# 454-14-64
SECTION "A"-"A"
3½" O.D. TUBING ½" WALL x 2¼" LG., A-53
STK# 454-179-8, 2-REQ'D.
DWG. 453-124
TO SUIT @ ASS'Y
SECTION "B-B"
PIPE NIPPLE~T.O.E.
SCH. 80 X 6½" LG.~A-53
STK# 452-590
2" CHECK VALVE~MIDLAND A-144-E
STK# 275-73~STL~(VAPOR)
½" CHECK VALVE~303 SST
DWG 275-56
SEE DETAIL "A"
SEE DETAIL "B"
SEE DETAIL "C"
℄ TANK
TEST TUBE~T.O.E.
SCH 80 X 120" LG~A-120
STK# 454-60-5
(BEND @ ASS'Y)
PIPE BRACKET~A-36
DWG 450-118
2 REQ'D
PIPE GUIDE
DWG 453-124
2 REQ'D~A-36
4R
14½"
85"
THERMOMETER WELL
SCH 80 X 106" LG
STK# 454-59-13
A-53
1½" SCH 80 X 108" LG.
PIPE GUIDE W/HOLES
DWG 453-74
A-53
1" DIA STUD BOLT X 5" LG.
DWG. 39-493
20 REQ'D
18" MANWAY COVER
DWG 339-402
S END
1⅛" HVY HEX NUT
STK# 3-23
20 REQ'D
STL
2" CHECK VALVE~MIDLAND A-134-W
STK# 275-69~STL~(LIQUID)
2 REQ'D
"A"
DWG 209-46
DWG 6-4-6
STK# 454-14-64
ANGLE
DWG 6-4-6
2 REQ'D
PIPE CLAMP
DWG 209-46
2 REQ'D
PIPE CAP~STL
STK# 456-18
3000# "B"
"B"
2"
6¾"
DWG 450-118
2½"
DWG 453-74
STK# 454-179-8
SEE DETAIL "D"
STK# 275-69
DISCHARGE PIPE~A-53
2" SCH 80 SMLS PIPE X 114" LG
STK# 454-14-64
2 REQ'D
NOTE:
APPLY GASKET STK# 723-507
TO MANWAY, 19¼" I.D. X ⅛" THK X 20¼" O.D.
JM #76 ASBESTOS
STK# 454-590
STK# 454-59-13
DWG 453-74
DETAIL "A"
DETAIL "B"
DETAIL "C"
STK# 275-69
STK# 275-73
DETAIL "D"
EDUCTION PIPE ARRANGEMENT
119" I.D. TANK ~ TWO (2) 2" SCH 80
SEAMLESS STEEL EDUCTION PIPES
GATX
DISCHARGE
TS
JSP
1:1
17" x 22"
132-240
1132-282
2-8-63

10-07-75

RAILROAD TANK CAR SAFETY RESEARCH AND TEST PROJECT AN RPI-AAR COOPERATIVE PROGRAM

October 7, 1975

Mr. Ross Gill, Project Manager
Rail Operations Control
U. S. Department Transportation Test Center
Pueblo, CO 81001

Dear Mr. Gill:

Subject: Phase 15 - Orange Book

Enclosed are two copies of addition (17) to the Orange Book.

Larry Schlink asked me to send you advance copies as you are ready to use this section in the present Switchyard Impact Test Program.

Sincerely,

C. E. Reedy

C. E. Reedy

CER/jb

cc Mr. Larry Schlink - attachments

Reply to: Project Director — Tank Car Research
Association of American Railroads, Technical Center
3140 South Federal Street, Chicago, Illinois 60616
312-225-9600 ext 863

RPI-AAR TANK CAR SAFETY PROJECT
PHASE 15, SWITCHYARD IMPACT TEST PROGRAM

Procedure for Pressurizing Tank Cars of DOT 112A Specification

I. Safety Precautions

1. Place caution sign on track a safe distance in front of and to the rear of tank car to indicate workman on car.

2. Set handbrake on car and/or

3. Place wood wedge blocks on track in front and rear of one set of wheels.

II. Preparation of Tank Pressure Test

1. Refer to Sketch 17-1, and open Manway Housing Cover (7).

2. Make up a hose line (1), air line shut-off valve (2), pressure indicating gage (3), and suitable pipeline (4) to connect to the tank car vapor valve (5).

3. Confirm that tank was filled with water to desired level before connecting pressure pipe (4) to car vapor valve (5).

III. Pressurizing Tank Car

1. Connect pipe line (4) to tank car vapor valve (5). Open vapor valve (5).

2. Open air line valve (2) to pressurize tank car.

3. Close air line valve (2) to determine correct pressure (3) in tank.

4. When tank pressure gage (3) reads 100 psi, close tank vapor valve (5).

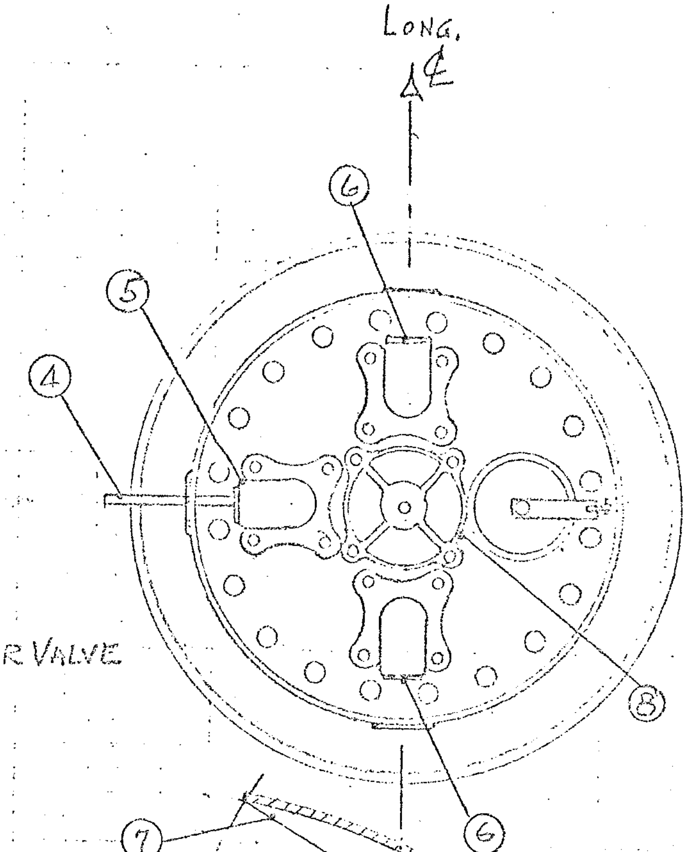
5. Disconnect air line pipe (4) from vapor valve (5).

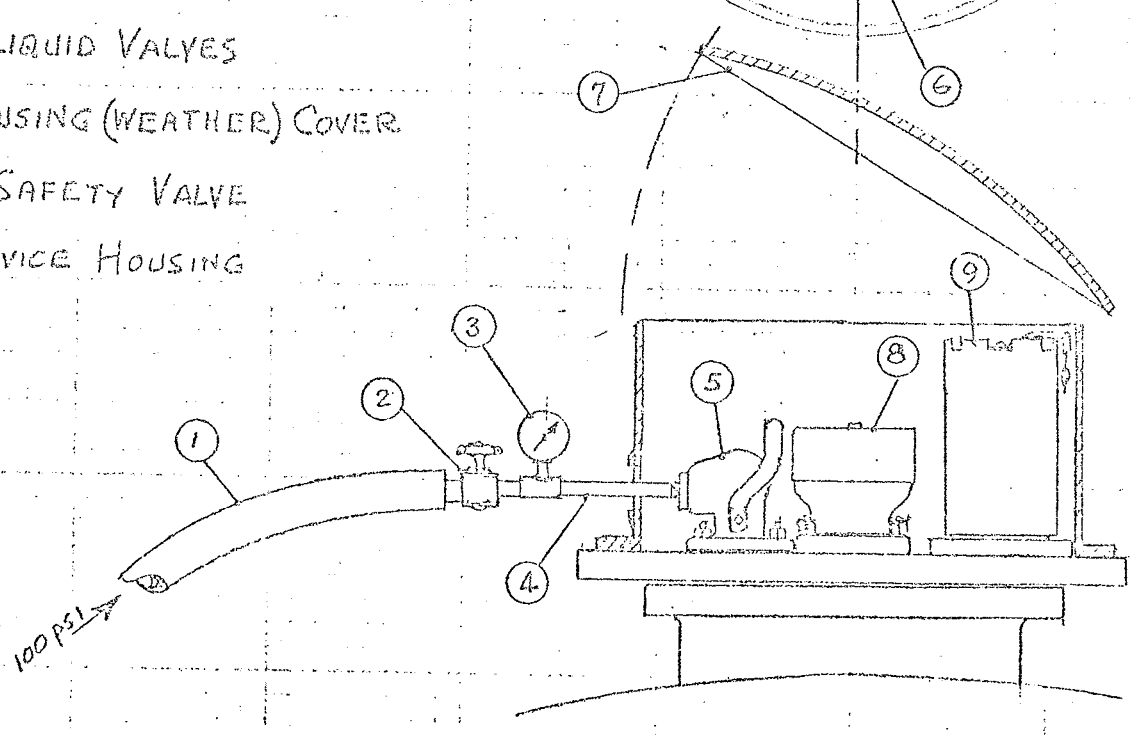
6. Remove caution signs from track and release hand brake and/or remove wheel wedge blocks.

IV. De-pressurizing Tank Car

1. After impact test is completed, open tank car vapor valve (5) to release 100 psi air from tank.

(1) - AIR LINE HOSE TO 100psi AIR LINE
(2) - AIR LINE SHUTOFF VALVE.
(3) - PRESSURE GAGE 0-150psi
(4) - PIPE LINE BTWN HOSE AND TANK CAR VAPOR VALVE
(5) - TANK CAR VAPOR VALVE
(6) - TANK CAR LIQUID VALVES
(7) - MANWAY HOUSING (WEATHER) COVER
(8) - TANK CAR SAFETY VALVE
(9) - GAUGING DEVICE HOUSING





AN RPI-AAR COOPERATIVE PROGRAM

MADE BY CER	FOR PROCEDURE FOR PRESSURIZING TANK CARS	LOT NO.
CHECKED BY	SUBJECT PHASE 15 - SWITCHYARD IMPACT TESTS	EST. NO.
APP'D. BY		DATE 10-6-75
REV.	REFERENCES	SKETCH 17-1

RPI-AAR TANK CAR SAFETY PROJECT
PHASE 15, SWITCHYARD IMPACT TEST PROGRAM

Procedure for Pressurizing Tank Cars of DOT 112A Specification

I. Safety Precautions

1. Place caution sign on track a safe distance in front of and to the rear of tank car to indicate workman on car.
2. Set handbrake on car and/or
3. Place wood wedge blocks on track in front and rear of one set of wheels.

II. Preparation of Tank Pressure Test

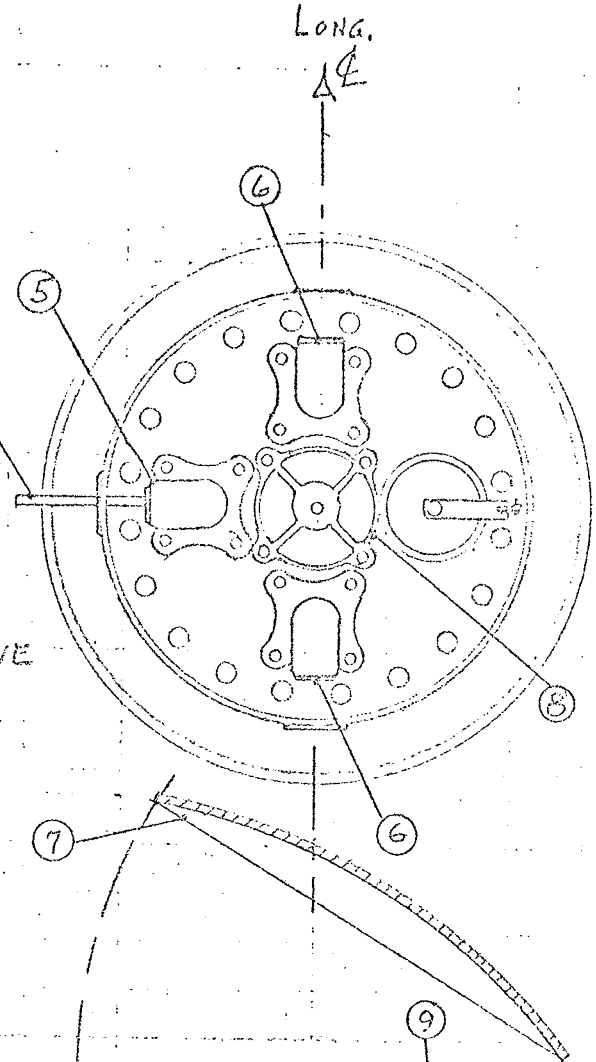
1. Refer to Sketch 17-1, and open Manway Housing Cover (7).
2. Make up a hose line (1), air line shut-off valve (2), pressure indicating gage (3), and suitable pipeline (4) to connect to the tank car vapor valve (5).
3. Confirm that tank was filled with water to desired level before connecting pressure pipe (4) to car vapor valve (5).

III. Pressurizing Tank Car

1. Connect pipe line (4) to tank car vapor valve (5). Open vapor valve (5).
2. Open air line valve (2) to pressurize tank car.
3. Close air line valve (2) to determine correct pressure (3) in tank.
4. When tank pressure gage (3) reads 100 psi, close tank vapor valve (5).
5. Disconnect air line pipe (4) from vapor valve (5).
6. Remove caution signs from track and release hand brake and/or remove wheel wedge blocks.

IV. De-pressurizing Tank Car

1. After impact test is completed, open tank car vapor valve (5) to release 100 psi air from tank.



① - AIR LINE HOSE TO 100psi AIR LINE

② - AIR LINE SHUTOFF VALVE.

③ - PRESSURE GAGE 0-150psi

④ - PIPE LINE BTWN HOSE AND TANK CAR VAPOR VALVE

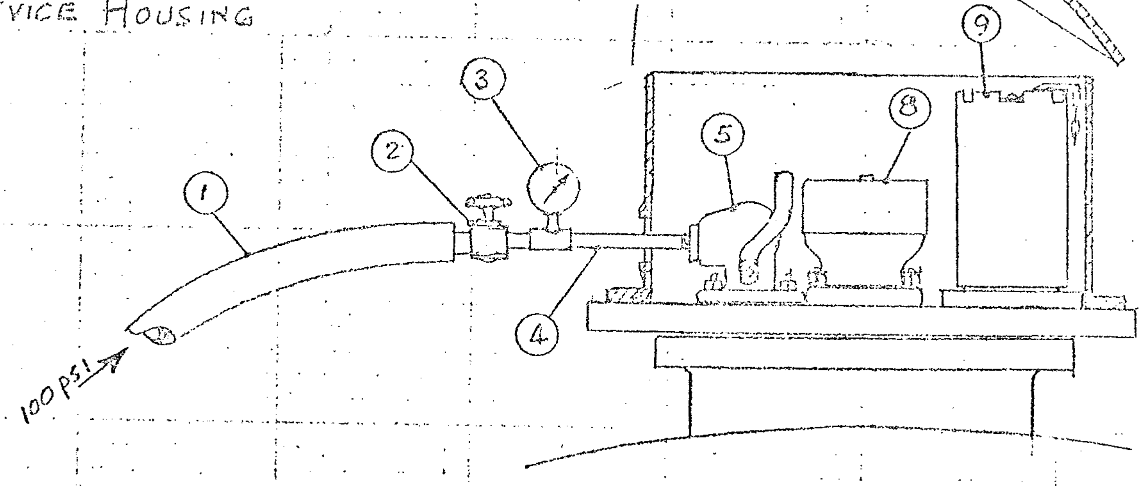
⑤ - TANK CAR VAPOR VALVE

⑥ - TANK CAR LIQUID VALVES

⑦ - MANWAY HOUSING (WEATHER) COVER

⑧ - TANK CAR SAFETY VALVE

⑨ - GAUGING DEVICE HOUSING



AN RPI-AAR COOPERATIVE PROGRAM

MADE BY CER	FOR PROCEDURE FOR PRESSURIZING TANK CARS	LOT NO.
CHECKED BY	SUBJECT PHASE 15 - SWITCHYARD IMPACT TESTS	EST. NO.
APP'D. BY		DATE 10-6-75
REV.	REFERENCES	SKETCH 17-1

RAILROAD TANK CAR SAFETY RESEARCH AND TEST PROJECT

AN RPI-AAR COOPERATIVE PROGRAM

October 6, 1975

Mr. R. T. Gill
Rail Operations Controller
U. S. Department of Transportation
Transportation Test Center
Pueblo, Colorado 81004

SUBJECT: Switchyard Impact Tests - RPI-AAR Phase 15

Dear Mr. Gill:

1. As requested at the October 1 - October 2, 1975 meeting, the following wording is suggested to describe the responsibilities of the RPI-AAR Phase leader (or his alternates):

1.4.2

L. J. Schlink will be the RPI-AAR Phase leader for the Phase 15 switchyard impacts. It will be his responsibility to insure that:

a. The RPI-AAR commitments to this program are fulfilled in an orderly manner,

b. Test data suitable to the RPI-AAR is obtained,

c. Any conflict regarding the conduction of the test and changes in the test program are resolved to the mutual satisfaction of the RPI-AAR and the DOT.

J. E. Everett, E. L. Kunz, and/or L. L. Olson will serve as alternates.

(cont'd...

Reply to: Project Director — Tank Car Research
Association of American Railroads, Technical Center
3140 South Federal Street, Chicago, Illinois 60616
312-225-9600 ext 863

2. For test consistency, Test Series 10 of the test matrix should precede Test Series 9. That is, the column titled "Head Shields" should read 'no' for Test Series 9 and 'yes' for Test Series 10.

3. Enclosed for your information are three tabulations that were developed using the impact test schedule, Figure B-1, and by assuming impact velocities for each test series. Accordingly, cars will be scheduled for arrival at TTC as per Table 3. Note that the number of 112A cars has increased from 26 to 28 due to expansion of test matrix to include Test 10.

4. As also requested at the Oct. 1 - Oct 2 meeting, I have discussed the question of grid lines on the RPI-AAR movies with Earl Phillips. We have no objection to grids on our movies.

5. In the "Test Specifications" under Par.2.2e, the AAR reference for restoring the butt end of the coupler is "Manual of Standards and Recommended Practices" Specification M-204A-68 Figure 8.

Very truly yours,

L. J. Schlink

mr

cc: D. M. Dancer
J. E. Everett
E. L. Kunz
L. L. Olson
E. A. Phillips

SERIES	VELOCITY (MPH) START	INCREMENT	FINAL	REMARKS
Preliminary	4	2	8	No damage
(1)	4	2	Destruction	Repeat non-destructive impacts
(2)	Uncoupling	2	Destruction	
(3)	Final from (2)	2	Destruction	
(4)	Final from (2)	--	---	One test only
(5)	Final from (2)	--	---	One test only
(6)	Final from (2)	--	---	One test only
(7)	4 mph less than final from (2)	2	Destruction	
(8)	Final from (2)	2	Destruction	
(9)	4	2	Destruction	
(10)	Final from (9)	2	Destruction	
(11)	4	2	8	No damage

Note: 1) It is assumed that Test (11) will be scheduled prior to final test series so that Test (11) car(s) can be used in destructive tests.
2) All tests that do not start at 4 mph are to be preceded by 4 mph impact for instrumentation check.

TABLE 2

CAR REQUIREMENTS

TEST	ASSUMED VELOCITIES	TANK CARS	HOPPER CARS
1	4 - 10	1	2
	12	1	1
	14	1	1
	16	1	1
2	8 - 10	1	2
	12	1	1
	14	1	1
	16	1	1
3	16	1	1
	18	1	1
4	16	1	1
5	16	1	1
6	16	1	1
7	14	1	1
	16	1	1
	18	1	1
8	16	1	1
	18	1	1
	20	1	1
	22	1	1
9	4 - 10	1	2
	12	1	1
	14	1	1
	16	1	1
	18	1	1
10	18	1	1
	20	1	1
	22	1	1
TOTAL		28	31

Note: 1) Tank cars assumed unusable after 10 mph impact
2) Hopper cars assumed unusable after 8 mph impact
Uncoupling velocity assumed to be 8 mph

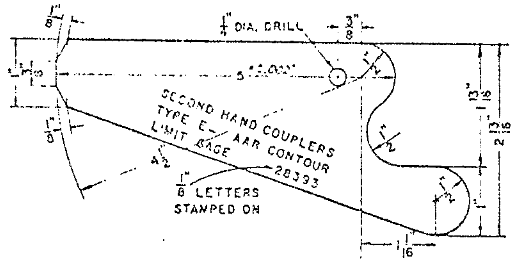
TABLE 3

CAR REQUIREMENTS

TEST SERIES	TANK CARS		NUMBER REQUIRED		DATE REQUIRED AT TTC
	COUPLERS	HEAD SHIELDS	HOPPER	TANK	
1	E (Std)	No	5	4	10 Nov 75
2	E (Std)	No	5	4	8 Dec 75
3	E (Std)	Yes	2	2	12 Jan 76
4	F (Std)	No	1	1	9 Feb 76
5	E (Shelf)	No	1	1	8 Mar 76
6	F (Shelf)	No	1	1	5 Apr 76
7	E (Std)	Yes	3	3	3 May 76
8	E (Shelf)	Yes	4	4	1 Jun 76
9	E (Std)	No	6	5	28 Jun 76
10	E (Std)	Yes	3	3	26 Jul 76
			31	28	

2 additional impacting cars (not 112A or 114A) are required at TTC on June 28, 1976

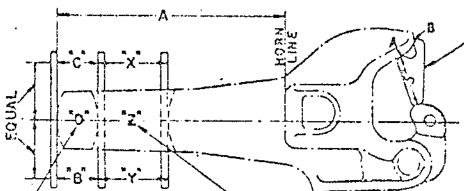
PLATE I.



USE OF GAGE:
THIS COUPLER CONTOUR IS CONDEMNED WHEN THE GAGE CAN BE PASSED VERTICALLY THROUGH THE CONTOUR IN POSITION SHOWN AND WITH POINTS "A" AND "B" CONTACTING GUARD ARM.

1/8" STEEL PLATE - HARDEN & FINISH CONTACT POINTS.
CONTOUR LIMIT GAGE NO.28393

FIG. 1



CATALOG NO.	DIM. "A"		DIM. "Z"
	MIN.	MAX	MIN.
E60	21"	21 3/8"	6 1/2"
E63, B-E63-HT B-E63A-HT	21"	21 3/8"	5"
B-E60A-HT	21"	21 5/8"	6 3/4"
B-E67-HT	24 1/2"	25 1/8"	8 1/2"

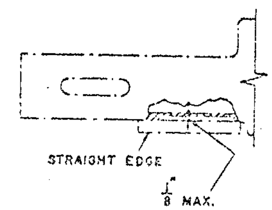
THIS DIMENSION "D" TO BE 3 7/8" MIN. 4 3/32" MAX. AND IS DETERMINED BY TAKING 1/2 THE SUM OF MEASUREMENTS "B" AND "C".

THIS DIMENSION TO BE DETERMINED BY TAKING 1/2 THE SUM OF MEASUREMENTS "X" AND "Y" AND SHALL BE GREATER THAN "Z" MIN. IN TABLE.

SHANK LENGTH AND KEYSLOT LIMIT
RIGID SHANK COUPLERS.

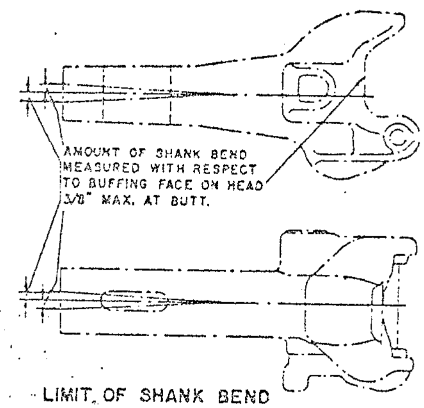
FIG. 2

PLATE III.



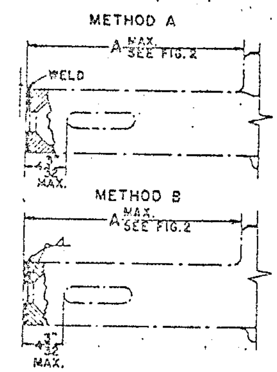
LIMIT OF WEAR ON BOTTOM
OF SHANK FROM CONTACT
WITH CARRIER

FIG. 6



LIMIT OF SHANK BEND

FIG. 7



WORN COUPLER BUTT MAY BE RESTORED AS SHOWN BY ELECTRIC WELDING. WELDED SURFACE SHOULD BE REASONABLY SMOOTH AND IN A PLANE PERPENDICULAR TO THE CENTER LINE OF THE SHANK.

WORN COUPLER BUTT MAY BE RESTORED BY WELDING ON A STEEL PLATE AS SHOWN. THE BUTT MUST FIRST BE MACHINED PERPENDICULA[R] TO THE CENTER LINE OF THE SHA[NK] THE PLATE MUST BE SMALLER THA[N] THE BUTT SURFACE TO PROVIDE SPACE FOR WELDING EQUAL IN WIDT[H] TO THE PLATE THICKNESS UP TO 1/4

METHODS OF RESTORING RIGID SHANK LENGTH

FIG. 8

CC: A. Kiefer OCT 21 REC'D

RAILROAD TANK CAR SAFETY RESEARCH AND TEST PROJECT

AN RPI-AAR COOPERATIVE PROGRAM

October 17, 1975

Mr. Ross Gill
Rail Operations Controller
U. S. Department of Transportation
Transportation Test Center
Pueblo, Colorado 81004

SUBJECT: Switchyard Impact Tests - RPI-AAR Phase 15

Dear Mr. Gill:

1. Enclosed is the procedure for filling the tank cars with water to the rail load limit. This procedure was prepared by J. E. Everett as requested at the October 1, 1975 meeting.

2. For your information, GATX has also calculated heat loss on a 33,500 gallon tank and find that if loaded with 21,500 gallons of water at 60°F and allowed to stand in a 0°F environment, the water will drop to 32°F in 29 hours with no wind and 20 hours with a 10 mph wind.

3. We have contacted Mr. N. Morella, as requested, and he advises that raising the cut lever after the coupler knuckle is open will be the best assurance that the knuckle thrower is clear of the knuckle lock.

(cont'd...

Reply to: Project Director — Tank Car Research
Association of American Railroads, Technical Center
3140 South Federal Street, Chicago, Illinois 60616
312-225-9600 ext 863

4. GATX 57688 and GATX 92571 are now at General American's Argentine, Kansas repair shop being conditioned for test purposes. This completes the estimated package of 4 tank cars required for Series 1 testing. It is anticipated these cars will be at TTC by November 10, 1975.

Very truly yours,

L. J. Schlink

mr
Enclosure

cc: D. M. Dancer
J. E. Everett
E. L. Kunz
L. L. Olson
E. A. Phillips
C. E. Reedy

TANK FILL PROCEDURE

A. PRELIMINARY CALCULATIONS TO DETERMINE TANK OUTAGE REQUIRED.

1. Determine weight of water to be put in car to bring car to 263,000 pounds. Subtract light weight of car (stenciled on side of car) from 263,000 pounds. Convert this weight to gallons by dividing by 8.33.

2. Determine outage (vapor space above liquid) in gallons by subtracting the volume, in gallons, to be put in the tank from the total capacity of tank, in gallons. The total gallon capacity is stenciled on the head of the tank.

3. Determine outage in inches for the above outage requirements in gallons by referring to the proper outage table for the car in question.

   EXAMPLE:

   Tank car lightweight 85,300 pounds (assumed)
   Find weight of water to put in tank
   263,000 - 85,300 = 177,000 pounds
   Find volume in gallons
   177,000 ÷ 8.33 = 21,248 gallons
   Find outage in gallons
   From head of tank, capacity is 33,653 gallons
   33,653 - 21,248 = 12,405 gallons outage req'd.
   Find outage in inches from outage table
   Looking at table, 12,405 gallons = 47-1/4 inches

B. PROCEDURE FOR FILLING TANK

1. Set liquid level outage gage to 47-1/4 inches, open valve on top of gage.

2. Connect water fill hose to one of the two (2) tank eduction angle valves. These are the large valves on the longitudinal center line of the car. The other valve to be closed.

3. Open the eduction angle valve to which the water hose is connected and turn on water and begin to fill tank.

4. When water starts into tank, crack the induction angle valve. This is the large valve off of the longitudinal center line. Regulate this valve so that some air bleeds out of the tank but maintains a slight pressure (3 to 5 PSI) in the tank so that air also bleeds out of the liquid level tube. This pressure is not critical. Its only purpose is to insure that when the level of water reaches the bottom of the liquid level outage gage tube some water squirts out of the top of the tube to indicate the tank is at the level set on the tube. The pressure should not be so high as to oppose the flow of water into the tank.

5. When water squirts out of the liquid level tube the water is to be shut off. Open the induction valve wide to relieve any pressure in the tank and disconnect water line. Push the liquid level tube down and lock it and close its valve. Close the induction and eduction valves. The tank is now at 263,000 pounds.

C. PROCEDURE FOR EMPTYING TANK

1. Open induction valve (this is the valve off of the longitudinal center line) to relieve any pressure in the tank.

2. Connect an air line to the induction valve.

3. Connect a nipple approximately 12" long to either eduction valve so water will discharge outside housing. (eduction valve is either one on longitudinal center line).

4. Open eduction and induction valve and turn on air to tank. (max. pressure 100 PSI, 20 PSI should be adequate.

5. When tank is empty, shut off air supply and disconnect hose. Open induction valve to relieve pressure in the tank. When pressure is relieved, close all valves.

OUTAGE TABLE NO. 6895

GALLONS PER INCH IN MANWAY 1.1[illegible]

INS	GALS	INS	GALS	INS	GALS	INS	GALS	INS	GALS	INS	GALS
0	2	10	1320	20	3664	30	6585	40	9877	50	133[illegible]
1/4	3		1365		3733		6663		9959		13478
1/2	13		1419		3800		6742		10045		13560
3/4	2[illegible]		1470		3869		6820		10131		13658
1	4[illegible]	11	1521	21	3936	31	6900	41	10217	51	13748
1/4	61		1572		4005		6979		10303		13838
1/2	80		1624		4073		7058		10389		13928
3/4	100		1677		4142		7138		10476		14018
2	121	12	1729	22	4212	32	7218	42	10562	52	14108
1/4	144		1783		4281		7298		10649		14198
1/2	169		1837		4352		7378		10736		14288
3/4	194		1892		4422		7459		10823		14378
3	221	13	1947	23	4492	33	7540	43	10910	53	14469
1/4	248		2002		4563		7621		10997		14559
1/2	277		2058		4635		7702		11084		14650
3/4	307		2115		4706		7783		11172		14740
4	338	14	2172	24	4778	34	7865	44	11259	54	14830
1/4	370		2229		4850		7946		11347		15012
1/2	402		2287		4923		8028		11429	55	15193
3/4	436		2346		4995		8110		11522		15374
5	471	15	2404	25	5069	35	8193	45	11610	56	15556
1/4	506		2464		5142		8275		11699		15737
1/2	543		2523		5215		8358		11787	57	15919
3/4	580		2583		5289		8440		11875		16100
6	618	16	2644	26	5363	36	8523	46	11963	58	16282
1/4	656		2705		5438		8607		12052		16464
1/2	696		2766		5512		8690		12140	59	16646
3/4	736		2828		5587		8773		12229		16828
7	777	17	2889	27	5663	37	8857	47	12318	60	17010
1/4	819		2953		5736		8941		12406		17191
1/2	861		3016		5814		9025		12495	61	17373
3/4	904		3079		5890		9109		12584		17555
8	948	18	3143	28	5966	38	9193	48	12673	62	17737
1/4	992		3207		6043		9278		12762		17918
1/2	1037		3271		6119		9362		12852	63	18100
3/4	1083		3336		6196		9447		12941		18281
9	1129	19	3401	29	6273	39	9532	49	13030	64	18463
1/4	1176		3467		6351		9617		13120	11[illegible]	18657
1/2	1223		3533		6429		9703		13200	EMPTY	
3/4	1277		3599		6507		9788		13200		

ZERO INCHES REPRESENTS MANWAY NOZZLE CAPACITY
** REPRESENTS SHELL CAP. PLUS MANWAY CAPACITY

GATX 92930
91833
92561

NOV 4 REC'D

RAILROAD TANK CAR SAFETY RESEARCH AND TEST PROJECT

AN RPI-AAR COOPERATIVE PROGRAM

October 31, 1975

Mr. R. T. Gill
Rail Operations Controller
U. S. Department of Transportation
Transportation Test Center
Pueblo, Colorado 81004

SUBJECT: Phase 15 Switchyard Impact Tests

Dear Mr. Gill:

GATX 57688 and GATX 92571 are currently being prepared for shipment to TTC and are expected to be at North Avondale by November 10, 1975. These cars complete the package of four tank cars expected to be used in Series 1 testing. General American outage table No. 6895 (you have a copy) applies to these cars also.

UTLX 38482, UTLX 38493, UTLX 38498 and UTLX 38547 will be furnished for Series 2 tests. Enclosed are drawings (71075, 70883 and 70884), specifications and outage tables for these cars. (U.S. Table 1197 applies to UTLX 38482, 38547, and 38493. U.S. Table 1193 is for UTLX 38498.)

Very truly yours,

L. J. Schlink

/mr

cc: D. M. Dancer
J. E. Everett
E. L. Kunz
L. L. Olson
D. A. Peters
E. A. Phillips
C. E. Reedy

Reply to: Project Director — Tank Car Research
Association of American Railroads, Technical Center
3140 South Federal Street, Chicago, Illinois 60616
312-225-9600 ext 863

Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.
NOZZLE CAPACITY																	
1	GALLONS																
SHELL CAPACITY		14	2216	28	6087	42	10770	56	15850	70	20997	84	25892	98	30169	112	33272
1/4	5	1/4	2274	1/4	6165	1/4	10859	1/4	15943	1/4	21088	1/4	25975	1/4	30237	1/4	33311
1/2	15	1/2	2333	1/2	6243	1/2	10947	1/2	16035	1/2	21178	1/2	26058	1/2	30304	1/2	33348
3/4	28	3/4	2393	3/4	6321	3/4	11036	3/4	16127	3/4	21269	3/4	26140	3/4	30371	3/4	33385
1	43	15	2453	29	6400	43	11124	57	16220	71	21359	85	26223	99	30438	113	33421
1/4	60	1/4	2513	1/4	6479	1/4	11213	1/4	16312	1/4	21449	1/4	26305	1/4	30505	1/4	33456
1/2	79	1/2	2574	1/2	6558	1/2	11302	1/2	16404	1/2	21539	1/2	26387	1/2	30571	1/2	33491
3/4	99	3/4	2636	3/4	6638	3/4	11391	3/4	16497	3/4	21629	3/4	26469	3/4	30637	3/4	33524
2	121	16	2697	30	6717	44	11480	58	16589	72	21719	86	26550	100	30702	114	33556
1/4	144	1/4	2760	1/4	6797	1/4	11569	1/4	16681	1/4	21809	1/4	26632	1/4	30767	1/4	33587
1/2	169	1/2	2822	1/2	6877	1/2	11658	1/2	16774	1/2	21899	1/2	26713	1/2	30831	1/2	33618
3/4	195	3/4	2885	3/4	6958	3/4	11748	3/4	16866	3/4	21989	3/4	26794	3/4	30895	3/4	33647
3	222	17	2949	31	7038	45	11837	59	16958	73	22078	87	26875	101	30959	115	33675
1/4	251	1/4	3013	1/4	7119	1/4	11927	1/4	17051	1/4	22168	1/4	26955	1/4	31023	1/4	33702
1/2	280	1/2	3077	1/2	7200	1/2	12017	1/2	17143	1/2	22257	1/2	27036	1/2	31085	1/2	33727
3/4	311	3/4	3142	3/4	7282	3/4	12107	3/4	17235	3/4	22347	3/4	27116	3/4	31148	3/4	33752
4	342	18	3207	32	7363	46	12196	60	17328	74	22436	88	27195	102	31210	116	33775
1/4	375	1/4	3272	1/4	7445	1/4	12286	1/4	17420	1/4	22525	1/4	27275	1/4	31272	1/4	33796
1/2	405	1/2	3338	1/2	7527	1/2	12377	1/2	17512	1/2	22614	1/2	27354	1/2	31333	1/2	33816
3/4	443	3/4	3404	3/4	7609	3/4	12467	3/4	17605	3/4	22703	3/4	27434	3/4	31394	3/4	33834
5	478	19	3471	33	7691	47	12557	61	17697	75	22791	89	27512	103	31454	117	33851
1/4	515	1/4	3538	1/4	7773	1/4	12647	1/4	17789	1/4	22880	1/4	27591	1/4	31514	1/4	33865
1/2	552	1/2	3605	1/2	7856	1/2	12738	1/2	17882	1/2	22969	1/2	27669	1/2	31573	1/2	33877
3/4	590	3/4	3673	3/4	7939	3/4	12828	3/4	17974	3/4	23057	3/4	27748	3/4	31632	3/4	33886
6	628	20	3741	34	8022	48	12919	62	18066	76	23145	90	27826	104	31691	7/8	33889
1/4	668	1/4	3809	1/4	8105	1/4	13010	1/4	18158	1/4	23233	1/4	27903	1/4	31749		
1/2	708	1/2	3878	1/2	8189	1/2	13101	1/2	18251	1/2	23321	1/2	27981	1/2	31806		
3/4	749	3/4	3947	3/4	8272	3/4	13191	3/4	18343	3/4	23409	3/4	28058	3/4	31863		
7	791	21	4016	35	8356	49	13282	63	18435	77	23497	91	28135	105	31920		
1/4	834	1/4	4086	1/4	8440	1/4	13373	1/4	18527	1/4	23584	1/4	28211	1/4	31976		
1/2	877	1/2	4156	1/2	8525	1/2	13464	1/2	18619	1/2	23672	1/2	28288	1/2	32032		
3/4	921	3/4	4227	3/4	8609	3/4	13555	3/4	18711	3/4	23759	3/4	28364	3/4	32087		
8	966	22	4298	36	8693	50	13647	64	18803	78	23846	92	28439	106	32141		
1/4	1011	1/4	4369	1/4	8778	1/4	13738	1/4	18895	1/4	23933	1/4	28515	1/4	32195		
1/2	1057	1/2	4440	1/2	8863	1/2	13829	1/2	18987	1/2	24020	1/2	28590	1/2	32249		
3/4	1103	3/4	4512	3/4	8948	3/4	13921	3/4	19079	3/4	24107	3/4	28665	3/4	32302		
9	1151	23	4584	37	9033	51	14012	65	19171	79	24194	93	28740	107	32354		
1/4	1199	1/4	4656	1/4	9119	1/4	14104	1/4	19263	1/4	24280	1/4	28814	1/4	32406		
1/2	1247	1/2	4729	1/2	9204	1/2	14195	1/2	19355	1/2	24367	1/2	28888	1/2	32457		
3/4	1295	3/4	4802	3/4	9290	3/4	14287	3/4	19446	3/4	24453	3/4	28962	3/4	32508		
10	1346	24	4875	38	9376	52	14378	66	19538	80	24539	94	29036	108	32558		
1/4	1396	1/4	4949	1/4	9462	1/4	14470	1/4	19630	1/4	24625	1/4	29109	1/4	32608		
1/2	1447	1/2	5023	1/2	9548	1/2	14562	1/2	19721	1/2	24710	1/2	29182	1/2	32656		
3/4	1499	3/4	5097	3/4	9635	3/4	14654	3/4	19813	3/4	24796	3/4	29254	3/4	32705		
11	1551	25	5171	39	9721	53	14745	67	19904	81	24881	95	29327	109	32753		
1/4	1603	1/4	5246	1/4	9808	1/4	14837	1/4	19996	1/4	24966	1/4	29399	1/4	32800		
1/2	1656	1/2	5321	1/2	9895	1/2	14929	1/2	20087	1/2	25051	1/2	29470	1/2	32846		
3/4	1710	3/4	5397	3/4	9982	3/4	15021	3/4	20178	3/4	25136	3/4	29542	3/4	32892		
12	1764	26	5472	40	10069	54	15113	68	20270	82	25221	96	29613	110	32937		
1/4	1819	1/4	5548	1/4	10156	1/4	15205	1/4	20361	1/4	25305	1/4	29683	1/4	32981		
1/2	1874	1/2	5624	1/2	10243	1/2	15297	1/2	20452	1/2	25390	1/2	29754	1/2	33025		
3/4	1930	3/4	5701	3/4	10331	3/4	15389	3/4	20543	3/4	25474	3/4	29824	3/4	33068		
13	1986	27	5777	41	10418	55	15482	69	20634	83	25558	97	29893	111	33110		
1/4	2043	1/4	5854	1/4	10506	1/4	15574	1/4	20725	1/4	25642	1/4	29963	1/4	33152		
1/2	2100	1/2	5932	1/2	10594	1/2	15666	1/2	20816	1/2	25725	1/2	30032	1/2	33193		
3/4	2158	3/4	6009	3/4	10682	3/4	15758	3/4	20906	3/4	25809	3/4	30100	3/4	33233		

TABLE 1198

Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.
NOZZLE CAPACITY																	
1	GALLONS																
SHELL CAPACITY		14	2195	28	6031	42	10673	56	15710	70	20813	84	25669	98	29915	112	33005
* 1/4	5	1/4	2253	1/4	6108	1/4	10761	1/4	15801	1/4	20903	1/4	25752	1/4	29983	1/4	33043
1/2	15	1/2	2312	1/2	6186	1/2	10849	1/2	15893	1/2	20993	1/2	25834	1/2	30050	1/2	33081
3/4	27	3/4	2371	3/4	6264	3/4	10936	3/4	15984	3/4	21083	3/4	25916	3/4	30117	3/4	33118
1	42	15	2430	29	6342	43	11024	57	16076	71	21172	85	25998	99	30183	113	33154
1/4	59	1/4	2490	1/4	6420	1/4	11112	1/4	16167	1/4	21262	1/4	26079	1/4	30249	1/4	33189
1/2	78	1/2	2550	1/2	6499	1/2	11200	1/2	16259	1/2	21351	1/2	26161	1/2	30315	1/2	33223
3/4	98	3/4	2611	3/4	6577	3/4	11287	3/4	16350	3/4	21441	3/4	26242	3/4	30380	3/4	33257
2	120	16	2672	30	6656	44	11377	58	16442	72	21530	86	26323	100	30445	114	33289
1/4	143	1/4	2734	1/4	6735	1/4	11465	1/4	16534	1/4	21619	1/4	26403	1/4	30510	1/4	33321
1/2	168	1/2	2796	1/2	6815	1/2	11554	1/2	16625	1/2	21708	1/2	26484	1/2	30574	1/2	33351
3/4	193	3/4	2859	3/4	6895	3/4	11642	3/4	16717	3/4	21797	3/4	26564	3/4	30637	3/4	33381
3	220	17	2921	31	6974	45	11731	59	16808	73	21886	87	26645	101	30701	115	33409
1/4	248	1/4	2985	1/4	7054	1/4	11820	1/4	16900	1/4	21975	1/4	26724	1/4	30764	1/4	33436
1/2	278	1/2	3048	1/2	7135	1/2	11909	1/2	16991	1/2	22063	1/2	26804	1/2	30826	1/2	33462
3/4	308	3/4	3113	3/4	7215	3/4	11998	3/4	17083	3/4	22152	3/4	26884	3/4	30888	3/4	33487
4	339	18	3177	32	7296	46	12087	60	17175	74	22240	88	26963	102	30950	116	33510
1/4	372	1/4	3242	1/4	7377	1/4	12176	1/4	17266	1/4	22329	1/4	27042	1/4	31011	1/4	33533
1/2	405	1/2	3307	1/2	7458	1/2	12266	1/2	17358	1/2	22417	1/2	27121	1/2	31072	1/2	33553
3/4	439	3/4	3373	3/4	7540	3/4	12355	3/4	17449	3/4	22505	3/4	27199	3/4	31133	3/4	33572
5	474	19	3439	33	7621	47	12445	61	17541	75	22593	89	27278	103	31193	117	33589
1/4	510	1/4	3505	1/4	7703	1/4	12534	1/4	17632	1/4	22681	1/4	27356	1/4	31252	1/4	33605
1/2	547	1/2	3572	1/2	7785	1/2	12624	1/2	17724	1/2	22769	1/2	27433	1/2	31311	1/2	33618
3/4	584	3/4	3639	3/4	7867	3/4	12714	3/4	17815	3/4	22857	3/4	27511	3/4	31370	3/4	33628
6	622	20	3706	34	7949	48	12804	62	17907	76	22944	90	27588	104	31428	118	33634
1/4	662	1/4	3774	1/4	8032	1/4	12893	1/4	17998	1/4	23031	1/4	27665	1/4	31486	1/16	33635
1/2	702	1/2	3842	1/2	8115	1/2	12983	1/2	18090	1/2	23119	1/2	27742	1/2	31543		
3/4	742	3/4	3911	3/4	8197	3/4	13073	3/4	18181	3/4	23206	3/4	27819	3/4	31600		
7	784	21	3979	35	8281	49	13164	63	18273	77	23293	91	27895	105	31656		
1/4	826	1/4	4049	1/4	8364	1/4	13254	1/4	18364	1/4	23380	1/4	27971	1/4	31712		
1/2	869	1/2	4118	1/2	8447	1/2	13344	1/2	18455	1/2	23467	1/2	28047	1/2	31767		
3/4	912	3/4	4188	3/4	8531	3/4	13434	3/4	18547	3/4	23553	3/4	28123	3/4	31822		
8	956	22	4258	36	8615	50	13525	64	18638	78	23640	92	28198	106	31877		
1/4	1001	1/4	4328	1/4	8699	1/4	13615	1/4	18729	1/4	23726	1/4	28273	1/4	31930		
1/2	1047	1/2	4399	1/2	8783	1/2	13706	1/2	18820	1/2	23812	1/2	28348	1/2	31984		
3/4	1093	3/4	4470	3/4	8867	3/4	13796	3/4	18911	3/4	23898	3/4	28422	3/4	32036		
9	1140	23	4542	37	8952	51	13887	65	19002	79	23984	93	28496	107	32089		
1/4	1187	1/4	4614	1/4	9036	1/4	13978	1/4	19094	1/4	24070	1/4	28570	1/4	32140		
1/2	1235	1/2	4686	1/2	9121	1/2	14069	1/2	19185	1/2	24156	1/2	28644	1/2	32191		
3/4	1284	3/4	4758	3/4	9206	3/4	14159	3/4	19275	3/4	24241	3/4	28717	3/4	32242		
10	1333	24	4831	38	9291	52	14250	66	19366	80	24327	94	28790	108	32292		
1/4	1383	1/4	4903	1/4	9377	1/4	14341	1/4	19457	1/4	24412	1/4	28863	1/4	32341		
1/2	1434	1/2	4977	1/2	9462	1/2	14432	1/2	19548	1/2	24497	1/2	28935	1/2	32390		
3/4	1485	3/4	5050	3/4	9548	3/4	14523	3/4	19639	3/4	24582	3/4	29007	3/4	32438		
11	1536	25	5124	39	9633	53	14614	67	19730	81	24666	95	29079	109	32486		
1/4	1588	1/4	5198	1/4	9719	1/4	14705	1/4	19820	1/4	24751	1/4	29150	1/4	32533		
1/2	1641	1/2	5273	1/2	9805	1/2	14797	1/2	19911	1/2	24835	1/2	29221	1/2	32579		
3/4	1694	3/4	5347	3/4	9892	3/4	14888	3/4	20001	3/4	24919	3/4	29292	3/4	32625		
12	1748	26	5422	40	9978	54	14979	68	20092	82	25003	96	29363	110	32670		
1/4	1802	1/4	5497	1/4	10064	1/4	15070	1/4	20182	1/4	25087	1/4	29433	1/4	32714		
1/2	1856	1/2	5573	1/2	10151	1/2	15161	1/2	20273	1/2	25171	1/2	29503	1/2	32758		
3/4	1912	3/4	5649	3/4	10238	3/4	15253	3/4	20363	3/4	25254	3/4	29573	3/4	32801		
13	1967	27	5725	41	10325	55	15344	69	20453	83	25338	97	29642	111	32843		
1/4	2024	1/4	5801	1/4	10412	1/4	15435	1/4	20543	1/4	25421	1/4	29711	1/4	32884		
1/2	2080	1/2	5877	1/2	10499	1/2	15527	1/2	20634	1/2	25504	1/2	29779	1/2	32925		
3/4	2137	3/4	5954	3/4	10586	3/4	15618	3/4	20724	3/4	25587	3/4	29847	3/4	32965		

U.S. TABLE 1193

Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.
NOZZLE CAPACITY																	
1 GALLONS																	
SHELL CAPACITY		14	2220	28	6099	42	10792	56	15883	70	21040	84	25944	98	30230	112	33340
1/4	5	1/4	2279	1/4	6177	1/4	10881	1/4	15975	1/4	21131	1/4	26028	1/4	30298	1/4	33379
1/2	15	1/2	2338	1/2	6256	1/2	10969	1/2	16068	1/2	21221	1/2	26111	1/2	30366	1/2	33416
3/4	28	3/4	2398	3/4	6334	3/4	11058	3/4	16160	3/4	21312	3/4	26193	3/4	30433	3/4	33453
1	43	15	2459	29	6413	43	11147	57	16253	71	21402	85	26276	99	30500	113	33489
1/4	60	1/4	2519	1/4	6492	1/4	11236	1/4	16345	1/4	21493	1/4	26358	1/4	30567	1/4	33524
1/2	79	1/2	2580	1/2	6572	1/2	11325	1/2	16438	1/2	21583	1/2	26441	1/2	30633	1/2	33559
3/4	99	3/4	2641	3/4	6651	3/4	11414	3/4	16530	3/4	21673	3/4	26523	3/4	30699	3/4	33592
2	121	16	2703	30	6731	44	11503	58	16623	72	21764	86	26604	100	30764	114	33624
1/4	145	1/4	2765	1/4	6811	1/4	11593	1/4	16715	1/4	21854	1/4	26686	1/4	30829	1/4	33656
1/2	170	1/2	2828	1/2	6892	1/2	11682	1/2	16808	1/2	21944	1/2	26767	1/2	30894	1/2	33686
3/4	196	3/4	2891	3/4	6972	3/4	11772	3/4	16900	3/4	22034	3/4	26848	3/4	30958	3/4	33715
3	223	17	2955	31	7053	45	11862	59	16993	73	22123	87	26929	101	31022	115	33743
1/4	251	1/4	3019	1/4	7134	1/4	11951	1/4	17085	1/4	22213	1/4	27010	1/4	31086	1/4	33770
1/2	281	1/2	3083	1/2	7215	1/2	12041	1/2	17178	1/2	22303	1/2	27090	1/2	31149	1/2	33796
3/4	312	3/4	3148	3/4	7297	3/4	12131	3/4	17270	3/4	22392	3/4	27171	3/4	31211	3/4	33820
4	343	18	3213	32	7378	46	12221	60	17363	74	22481	88	27251	102	31273	116	33843
1/4	376	1/4	3279	1/4	7460	1/4	12312	1/4	17456	1/4	22571	1/4	27330	1/4	31335	1/4	33865
1/2	409	1/2	3345	1/2	7542	1/2	12402	1/2	17548	1/2	22660	1/2	27410	1/2	31397	1/2	33885
3/4	444	3/4	3411	3/4	7624	3/4	12492	3/4	17641	3/4	22749	3/4	27489	3/4	31457	3/4	33903
5	479	19	3478	33	7707	47	12583	61	17733	75	22838	89	27568	103	31518	117	33920
1/4	516	1/4	3545	1/4	7789	1/4	12673	1/4	17826	1/4	22926	1/4	27647	1/4	31578	1/4	33934
1/2	553	1/2	3612	1/2	7872	1/2	12764	1/2	17918	1/2	23015	1/2	27726	1/2	31637	1/2	33946
3/4	591	3/4	3680	3/4	7955	3/4	12855	3/4	18011	3/4	23104	3/4	27804	3/4	31697	3/4	33955
6	630	20	3748	34	8039	48	12945	62	18103	76	23192	90	27882	104	31755	7/8	33958
1/4	669	1/4	3817	1/4	8122	1/4	13036	1/4	18195	1/4	23280	1/4	27960	1/4	31813		
1/2	710	1/2	3886	1/2	8206	1/2	13127	1/2	18288	1/2	23369	1/2	28037	1/2	31871		
3/4	751	3/4	3955	3/4	8289	3/4	13218	3/4	18380	3/4	23457	3/4	28115	3/4	31928		
7	793	21	4025	35	8373	49	13309	63	18472	77	23545	91	28192	105	31985		
1/4	835	1/4	4095	1/4	8458	1/4	13401	1/4	18565	1/4	23632	1/4	28269	1/4	32041		
1/2	879	1/2	4165	1/2	8542	1/2	13492	1/2	18657	1/2	23720	1/2	28345	1/2	32097		
3/4	923	3/4	4235	3/4	8627	3/4	13583	3/4	18749	3/4	23807	3/4	28421	3/4	32152		
8	968	22	4306	36	8711	50	13675	64	18842	78	23895	92	28497	106	32207		
1/4	1013	1/4	4378	1/4	8796	1/4	13766	1/4	18934	1/4	23982	1/4	28573	1/4	32261		
1/2	1059	1/2	4449	1/2	8881	1/2	13857	1/2	19026	1/2	24069	1/2	28648	1/2	32314		
3/4	1106	3/4	4521	3/4	8967	3/4	13949	3/4	19118	3/4	24156	3/4	28723	3/4	32367		
9	1153	23	4593	37	9052	51	14041	65	19210	79	24243	93	28798	107	32420		
1/4	1201	1/4	4666	1/4	9138	1/4	14132	1/4	19302	1/4	24330	1/4	28873	1/4	32472		
1/2	1250	1/2	4739	1/2	9223	1/2	14224	1/2	19394	1/2	24416	1/2	28947	1/2	32523		
3/4	1299	3/4	4812	3/4	9309	3/4	14316	3/4	19486	3/4	24502	3/4	29021	3/4	32574		
10	1349	24	4885	38	9395	52	14408	66	19578	80	24589	94	29095	108	32624		
1/4	1399	1/4	4959	1/4	9481	1/4	14500	1/4	19670	1/4	24675	1/4	29168	1/4	32674		
1/2	1450	1/2	5033	1/2	9568	1/2	14592	1/2	19761	1/2	24760	1/2	29241	1/2	32723		
3/4	1502	3/4	5107	3/4	9654	3/4	14684	3/4	19853	3/4	24846	3/4	29314	3/4	32771		
11	1554	25	5182	39	9741	53	14776	67	19945	81	24932	95	29386	109	32819		
1/4	1606	1/4	5257	1/4	9828	1/4	14869	1/4	20036	1/4	25017	1/4	29458	1/4	32866		
1/2	1660	1/2	5332	1/2	9915	1/2	14960	1/2	20128	1/2	25102	1/2	29530	1/2	32913		
3/4	1713	3/4	5408	3/4	10002	3/4	15052	3/4	20219	3/4	25187	3/4	29602	3/4	32959		
12	1768	26	5483	40	10089	54	15144	68	20311	82	25272	96	29673	110	33004		
1/4	1823	1/4	5560	1/4	10177	1/4	15236	1/4	20402	1/4	25357	1/4	29744	1/4	33048		
1/2	1878	1/2	5636	1/2	10264	1/2	15329	1/2	20493	1/2	25441	1/2	29814	1/2	33092		
3/4	1934	3/4	5712	3/4	10352	3/4	15421	3/4	20585	3/4	25526	3/4	29884	3/4	33135		
13	1990	27	5789	41	10440	55	15513	69	20676	83	25610	97	29954	111	33178		
1/4	2047	1/4	5866	1/4	10528	1/4	15606	1/4	20767	1/4	25694	1/4	30024	1/4	33219		
1/2	2104	1/2	5944	1/2	10616	1/2	15698	1/2	20858	1/2	25777	1/2	30093	1/2	33260		
3/4	2162	3/4	6021	3/4	10704	3/4	15790	3/4	20949	3/4	25861	3/4	30162	3/4	33301		

U.S. TABLE 1194

Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.	Inches	Gals.
NOZZLE CAPACITY																	
14 GALLONS																	
SHELL CAPACITY		12	1132	24	3118	36	5526	48	8140	60	10788	72	13304	84	15497	96	17081
1/4	3	1/4	1167	1/4	3165	1/4	5579	1/4	8195	1/4	10842	1/4	13354	1/4	15538	1/4	17104
1/2	10	1/2	1203	1/2	3212	1/2	5632	1/2	8250	1/2	10896	1/2	13403	1/2	15578	1/2	17126
3/4	18	3/4	1238	3/4	3259	3/4	5685	3/4	8306	3/4	10951	3/4	13453	3/4	15618	3/4	17147
1	27	13	1274	25	3306	37	5738	49	8361	61	11005	73	13502	85	15658	97	17168
1/4	38	1/4	1311	1/4	3354	1/4	5792	1/4	8417	1/4	11059	1/4	13551	1/4	15698	1/4	17188
1/2	50	1/2	1347	1/2	3401	1/2	5845	1/2	8472	1/2	11113	1/2	13600	1/2	15737	1/2	17208
3/4	64	3/4	1384	3/4	3449	3/4	5899	3/4	8528	3/4	11167	3/4	13649	3/4	15776	3/4	17227
2	78	14	1422	26	3497	38	5952	50	8583	62	11221	74	13698	86	15815	98	17245
1/4	93	1/4	1459	1/4	3545	1/4	6006	1/4	8639	1/4	11275	1/4	13746	1/4	15853	1/4	17263
1/2	109	1/2	1497	1/2	3593	1/2	6059	1/2	8694	1/2	11329	1/2	13795	1/2	15891	1/2	17279
3/4	125	3/4	1535	3/4	3642	3/4	6113	3/4	8749	3/4	11382	3/4	13843	3/4	15929	3/4	17295
3	143	15	1573	27	3690	39	6167	51	8805	63	11436	75	13891	87	15966	99	17310
1/4	161	1/4	1612	1/4	3739	1/4	6221	1/4	8860	1/4	11490	1/4	13939	1/4	16004	1/4	17324
1/2	180	1/2	1651	1/2	3788	1/2	6275	1/2	8916	1/2	11543	1/2	13987	1/2	16041	1/2	17338
3/4	200	3/4	1690	3/4	3837	3/4	6329	3/4	8971	3/4	11596	3/4	14034	3/4	16077	3/4	17350
4	220	16	1730	28	3886	40	6383	52	9027	64	11650	76	14082	88	16114	100	17361
1/4	241	1/4	1770	1/4	3935	1/4	6437	1/4	9082	1/4	11703	1/4	14129	1/4	16150	1/4	17370
1/2	262	1/2	1810	1/2	3985	1/2	6491	1/2	9137	1/2	11756	1/2	14176	1/2	16185	1/2	17378
3/4	284	3/4	1850	3/4	4034	3/4	6546	3/4	9193	3/4	11809	3/4	14223	3/4	16221	3/4	17385
5	307	17	1891	29	4084	41	6600	53	9248	65	11862	77	14270	89	16256	101	17388
1/4	330	1/4	1931	1/4	4134	1/4	6655	1/4	9304	1/4	11915	1/4	14316	1/4	16291		
1/2	354	1/2	1972	1/2	4184	1/2	6709	1/2	9359	1/2	11968	1/2	14363	1/2	16325		
3/4	379	3/4	2014	3/4	4234	3/4	6764	3/4	9414	3/4	12021	3/4	14409	3/4	16359		
6	403	18	2055	30	4284	42	6818	54	9470	66	12073	78	14455	90	16393		
1/4	429	1/4	2097	1/4	4335	1/4	6873	1/4	9525	1/4	12126	1/4	14501	1/4	16426		
1/2	455	1/2	2139	1/2	4385	1/2	6927	1/2	9580	1/2	12178	1/2	14547	1/2	16459		
3/4	481	3/4	2181	3/4	4436	3/4	6982	3/4	9636	3/4	12231	3/4	14592	3/4	16492		
7	508	19	2224	31	4487	43	7037	55	9691	67	12283	79	14637	91	16524		
1/4	535	1/4	2266	1/4	4538	1/4	7092	1/4	9746	1/4	12335	1/4	14682	1/4	16556		
1/2	563	1/2	2309	1/2	4589	1/2	7147	1/2	9801	1/2	12387	1/2	14727	1/2	16587		
3/4	591	3/4	2353	3/4	4640	3/4	7202	3/4	9856	3/4	12439	3/4	14772	3/4	16619		
8	620	20	2396	32	4691	44	7256	56	9911	68	12491	80	14816	92	16649		
1/4	649	1/4	2440	1/4	4742	1/4	7311	1/4	9966	1/4	12542	1/4	14861	1/4	16680		
1/2	678	1/2	2483	1/2	4794	1/2	7366	1/2	10022	1/2	12594	1/2	14905	1/2	16710		
3/4	708	3/4	2527	3/4	4846	3/4	7422	3/4	10077	3/4	12646	3/4	14948	3/4	16739		
9	739	21	2572	33	4897	45	7477	57	10132	69	12697	81	14992	93	16768		
1/4	769	1/4	2616	1/4	4949	1/4	7532	1/4	10186	1/4	12748	1/4	15035	1/4	16797		
1/2	801	1/2	2661	1/2	5001	1/2	7587	1/2	10241	1/2	12799	1/2	15079	1/2	16825		
3/4	832	3/4	2706	3/4	5053	3/4	7642	3/4	10296	3/4	12850	3/4	15121	3/4	16853		
10	864	22	2751	34	5105	46	7697	58	10351	70	12901	82	15164	94	16880		
1/4	896	1/4	2796	1/4	5157	1/4	7752	1/4	10406	1/4	12952	1/4	15207	1/4	16907		
1/2	929	1/2	2841	1/2	5210	1/2	7808	1/2	10461	1/2	13003	1/2	15249	1/2	16933		
3/4	962	3/4	2887	3/4	5262	3/4	7863	3/4	10515	3/4	13053	3/4	15291	3/4	16959		
11	995	23	2933	35	5315	47	7918	59	10570	71	13104	83	15333	95	16985		
1/4	1029	1/4	2979	1/4	5367	1/4	7974	1/4	10624	1/4	13154	1/4	15374	1/4	17009		
1/2	1063	1/2	3025	1/2	5420	1/2	8029	1/2	10679	1/2	13204	1/2	15416	1/2	17034		
3/4	1097	3/4	3071	3/4	5473	3/4	8084	3/4	10733	3/4	13254	3/4	15457	3/4	17058		

UNION TANK CAR COMPANY

111 W. JACKSON BLVD., CHICAGO, ILL. 60604, TELEPHONE 431-3111, (AREA CODE 312)

MODEL NUMBER ISSUED

TANK CAR SPECIFICATIONS FOR QUOTATION NUMBER B.D. 67-100-34 (0969) DATE September 24, 1969

CUSTOMER U.T.C. Fleet COMMODITY LPG-AA WEIGHT PER GAL. 4.89#

DOT ~~XXX~~ 112A340W COMPTS 1 GALLONS NOMINAL CAPACITY 33,800 ALLOWABLE WEIGHT PER GALLON 5.1#

GENERAL DATA: SHELL CAPACITY 33,800 GALS. INCLUDES 0 % OUTAGE MAXIMUM WT. ON RAILS 263,000#
LIGHTWEIGHT OF CAR 38,600# LENGTH OVER STRIKERS 64'-10" LENGTH OVER TRUCK CENTERS 54'-6"
HEIGHT 15'-0½" WIDTH 10'-5½" RADIUS OF CURVATURE CAR CAN NEGOTIATE 238 Ft.

TANK: PLATE SPECIFICATION T.C. 128-B OUTSIDE DIAMETER: SHELL 119.3" HEADS 119.3"
PLATE THICKNESS – SHELL 5/8" HEADS 11/16" LENGTH OVER SEAMS 56'-2¼"
TANK TESTED TO 340 P.S.I. TANK INTERIOR PREPARATION Sweep Clean

HEATER PIPES: DESIGN None INLETS - OUTLETS - NO. OF RUNS -
SIZE - MATERIAL -

BODY: DESIGN HD (No Underframe) RUNNING BOARDS Top of Tank - AAR Approved
END PLATFORM AAR Approved SAFETY PLATFORM 2 Board - 4 Way
BRAKES WABCOPAC HAND BRAKE Vertical Handwheel

TRUCKS: DESIGN Barber CAPACITY 100-Ton JOURNAL BEARINGS Roller
WHEELS 36" One Wear MUDGUARDS None

INSULATION: None JACKET None

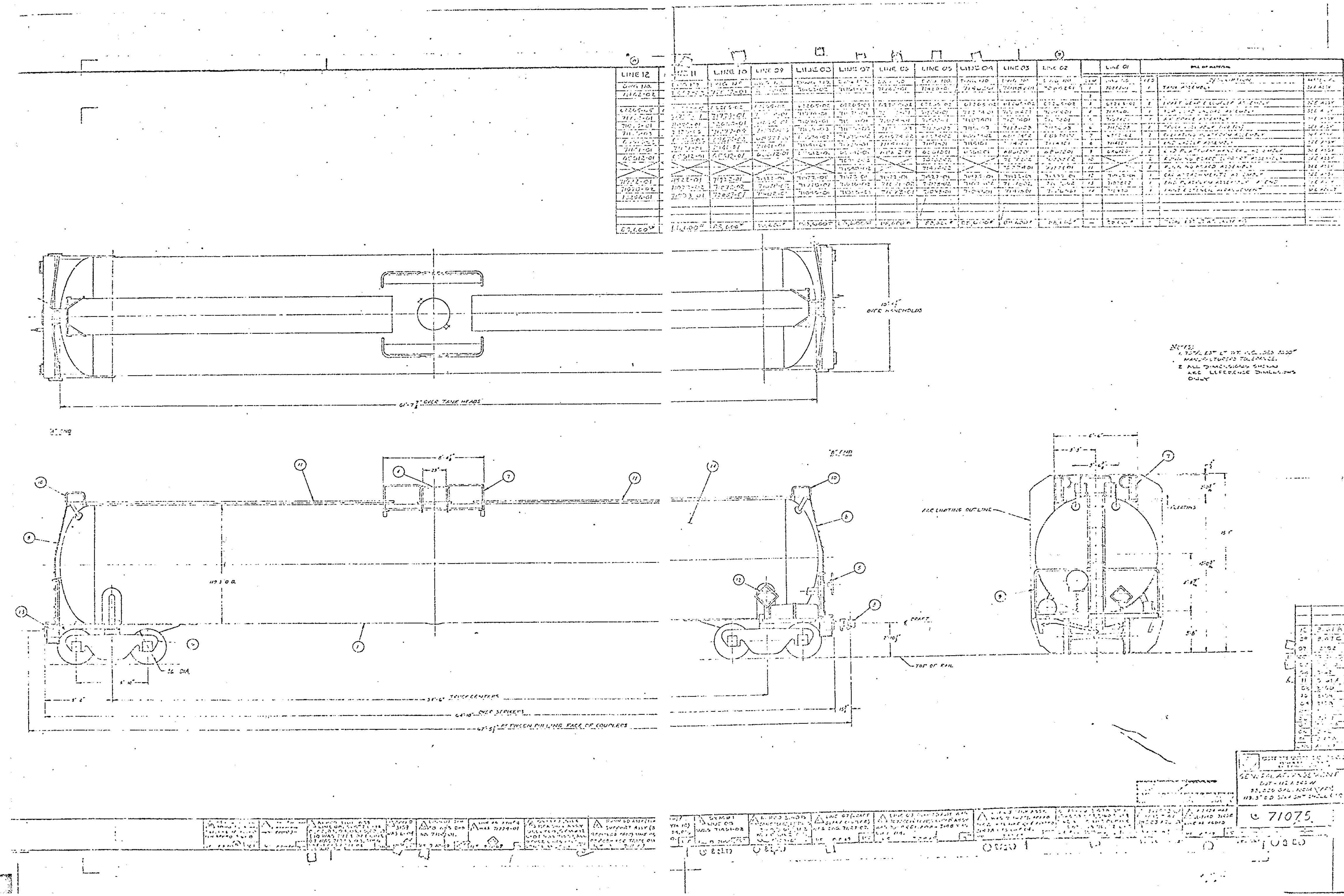
FITTINGS: BOTTOM UNLOADING None VALVE SIZE AND TYPE - CONNECTION -
OVERHEAD UNLOADING 2-2" VALVE SIZE AND TYPE Ball Type, Angle, Flanged Steel Body - SS Ball PIPE SIZE 2-3" Steel
AIR VALVE 1-2" SIZE AND TYPE Ball Type,Angle,Flanged,Steel Body-SS Ba
WASHOUT NOZZLE None VACUUM RELIEF VALVE None
SAFETY RELIEF Valve 280.5 PSI MANWAY COVER 18" Pressure Type TELL TALE None
THERMOMETER WELL 3/4" Steel SAMPLING LINE ¼" Steel (S.S. Valve)
GAUGING DEVICE Slip Tube GASKET MATERIAL Chemical Asbestos

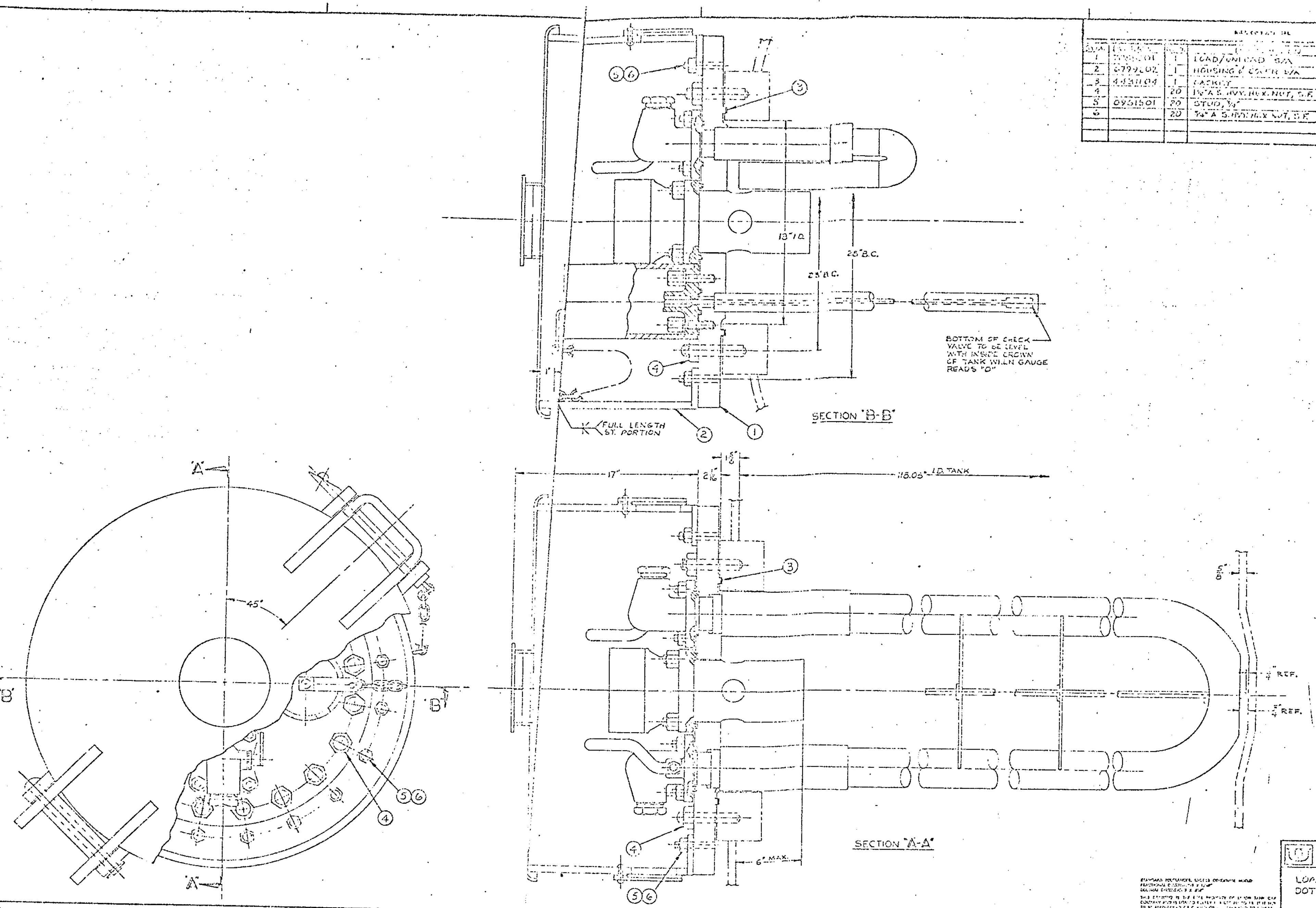
PAINT: FINISH Black and White Alkyd STENCILLING AAR-DOT
ADVERTISING None

LINING: None
RUBBER SADDLE None

SPECIAL DESIGN FEATURES:
1.0 Joint Efficiency
125-Ton Body Bolsters
Car Equipped with Excess Flow Valves

01-178A REV. 1/66


LINE 01
LINE 02
LINE 03
LINE 04
LINE 05
LINE 06
LINE 07
LINE 08
LINE 09
LINE 10
LINE 11
LINE 12
NOTES:
1. TOTAL LT. WT. INCLUDES MANUFACTURERS TOLERANCE.
2. ALL DIMENSIONS SHOWN ARE REFERENCE DIMENSIONS ONLY
OVER TANK HEADS
OVER HANDHOLDS
TRUCK CENTERS
OVER STRIKERS
BETWEEN PULLING FACE OF COUPLERS
TOP OF RAIL
EXCLUDING OUTLINE
GENERAL ARRANGEMENT
55,000 GAL.
71075



Item	Part No.	No. Req.	Description	Material
1	[illegible]	1	LOAD/UNLOAD S/A	[illegible]
2	6799202	1	HOUSING & COVER S/A	[illegible]
3	4431104	1	GASKET	[illegible]
4		20	1¼" A.S. HVY. HEX. NUT, S.F.	STEEL
5	0951501	20	STUD, ¾"	A 320
6		20	¾" A.S. HVY. HEX. NUT, S.F.	STEEL

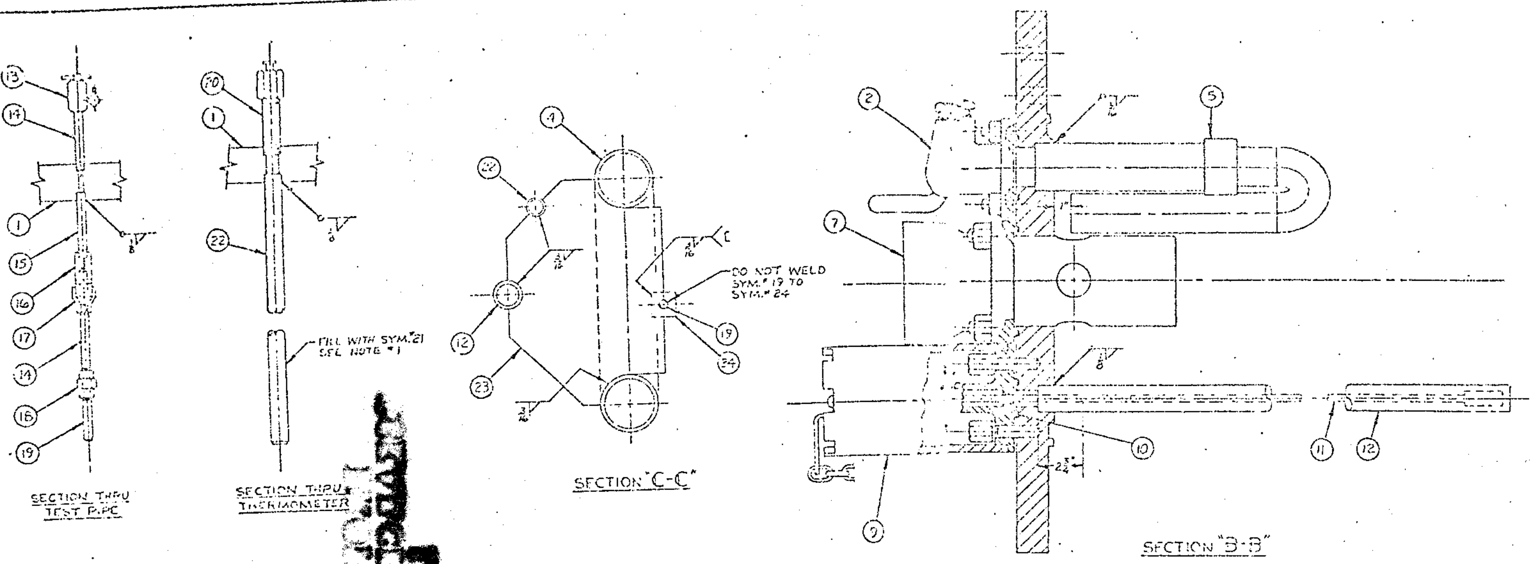
UNION TANK CAR CO.
EAST CHICAGO, INDIANA

LOAD/UNLOAD ASSY.
DOT 112A340W TANK CAR

70884

SYM #2 WAS DWG # 6799201

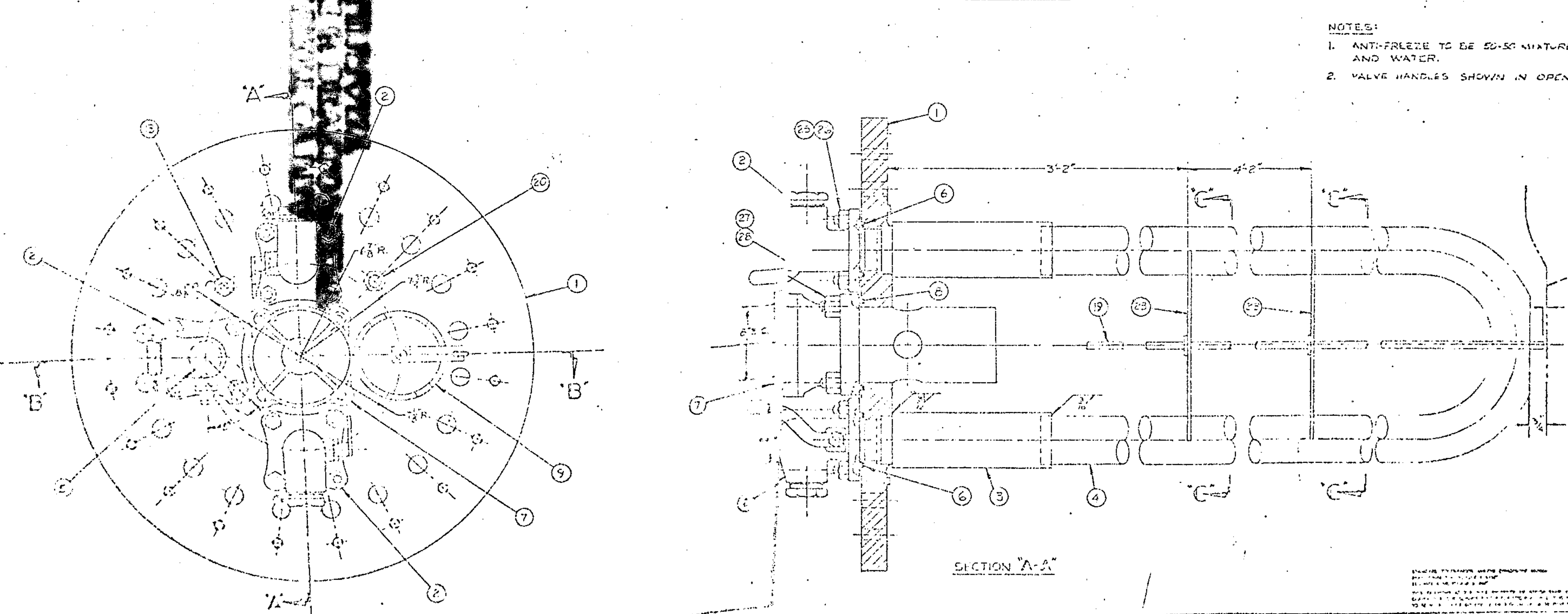
FIRST USED WITH



SYM.	[illegible]	[illegible]	[illegible]	
1	14562	1	FLANGE, MANWAY	[illegible]
2	70114	3	VALVE, 2" SA. [illegible]	[illegible]
3		2	VALVE, EXCESS FLOW, MIDLAND A-1G4W	SEE ASSY.
4	1249101	1	PIPE [illegible]	A-120
5		1	VALVE, EXCESS FLOW, MIDLAND A-[illegible]	SEE ASSY.
6	443105	3	GASKET	[illegible]
7		1	VALVE, SAFETY-MIDLAND A-3450, [illegible]	SEE ASSY.
8	443106	1	GASKET	[illegible]
9	57915	1	GAUGING DEVICE	SEE ASSY.
10	443107	1	GASKET	[illegible]
11	2707121	1	GAUGE ROD ASSY.	SEE ASSY.
12	0420410	1	PIPE, GAUGE	A-120
13	59441	1	VALVE, 1/4" NEEDLE	SEE ASSY.
14	1263422	2	PIPE, CUT-TO-LENGTH	A-120
15	1363554	1	PIPE, CUT-TO-LENGTH	A-120
16	C1151	1	VALVE, 1/4" CHECK	SEE ASSY.
17		1	REDUCER COUPLING, 3/4" TO 1/4", 3000# [illegible]	M.I.
18		1	UNION 1/4" FEMALE, 3000# A.A.R.	M.I.
19	C565822	1	PIPE, TEST	[illegible]
20	56370	1	FITTING, THERMOMETER WELL	SEE ASSY.
21	SEE NOTE #1	[illegible]	ANTIFREEZE, ETHYLENE GLYCOL	—
22	7050401	1	THERMOMETER WELL S/A	SEE S/A
23	13442	2	SUPPORT, PIPE	A-113-B
24	126C115	2	SQUARE SHAPE W/ONE HOLE	A-113-B
25	091574	12	STUD, 3/4"	A-310
26		12	3/4" A.S. HVY. HEX. NUT, S.F.	STEEL
27	0422007	4	STUD, 7/8"	A-320
28		4	7/8" A.S. HVY. HEX. NUT, S.F.	STEEL

NOTES:

1. ANTI-FREEZE TO BE 50-50 MIXTURE OF ETHYLENE GLYCOL AND WATER.
2. VALVE HANDLES SHOWN IN OPEN POSITION.



UNION TANK CAR CO.

LOAD/UNLOAD S/A
DOT 112A340W TANK CAR

70883

FIRST USED WITH 70884