

INTERNATIONAL RAILROAD TECHNOLOGY EXCHANGE

REPORT OF AUGUST 1977 U.S. RAILROAD DELEGATION'S
VISIT TO THE U.S.S.R. TO STUDY
SOVIET ROLLING STOCK TECHNOLOGY



SEPTEMBER 1979

FINAL REPORT

Document is available to the U.S. public through the
National Technical Information Service,
Springfield, Virginia 22161.

Prepared by

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
Office of Research and Development
Washington, D.C. 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

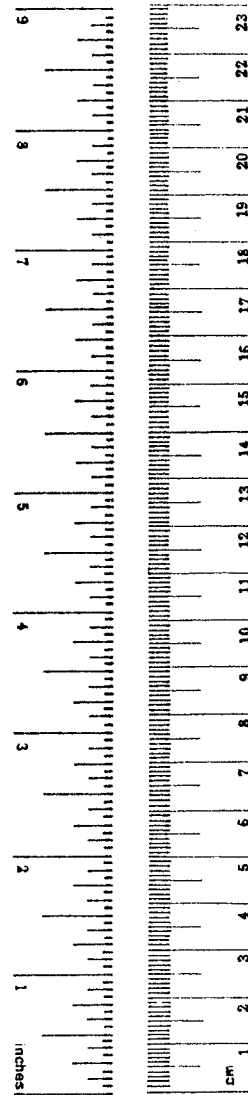
1. Report No. FRA/ORD-79/46		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle REPORT OF AUGUST 1977 U.S. RAILROAD DELEGATION'S VISIT TO THE U.S.S.R. TO STUDY SOVIET ROLLING STOCK TECHNOLOGY				5. Report Date September 1979	
				6. Performing Organization Code	
7. Author(s) F. A. Danahy				8. Performing Organization Report No.	
9. Performing Organization Name and Address Federal Railroad Administration Office of Research and Development 400 Seventh Street, SW. Washington, D.C. 20590				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Railroad Administration Office of Research and Development Washington, D.C. 20590				13. Type of Report and Period Covered Final Report August 3-15, 1977	
				14. Sponsoring Agency Code RRD-1	
15. Supplementary Notes Prepared as part of the International Railroad Technology Exchange Program.					
16. Abstract <p>This report summarizes the observations and findings of a seven-member delegation that visited the U.S.S.R. in August 1977 to participate in the sixth meeting of the Joint American-Soviet Railroad Working Group and to study and observe Soviet practices, procedures, and equipment used in designing, testing, manufacturing, and, to some degree, operating passenger and freight cars (including refrigerator cars). The delegation visited Soviet railroad facilities and related institutions in the Moscow, Kiev, Riga, and Leningrad areas, rode on intercity passenger trains, and conferred with numerous Soviet railroad officials.</p> <p>The delegation's observations and findings, together with some already published background data, are presented in this report in the form of detailed accounts of Soviet freight car maintenance activities, passenger car construction and maintenance, and refrigerator car manufacture and operations. The report also includes information on the Shcherbinka test loop and the Railway Engineering Institute (Leningrad), the full text of the recording of proceedings of the sixth working group meeting, and the titles and abstracts of the Soviet documents presented to the delegation.</p>					
17. Key Words U.S.S.R. Rolling Stock Technology, Design, Testing, Manufacture, Repair, Maintenance, and Operations.			18. Distribution Statement Document is available through the National Technical Information Service, Springfield, Virginia 22151.		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 55	22. Price

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

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

* 1 m = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 28b, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10:28b.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

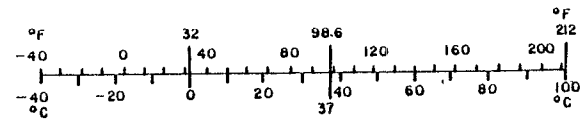


TABLE OF CONTENTS

	<u>Page</u>
SECTION 1: INTRODUCTION	1
SECTION 2: OVERVIEW OF SOVIET RAILROADS IN COMPARISON WITH U.S. RAILROADS	3
SECTION 3: RECENT AND PROJECTED GROWTH OF SOVIET RAILROADS.	5
SECTION 4: FREIGHT CAR MAINTENANCE--HEAVY REPAIRS	7
SECTION 5: FREIGHT CAR MAINTENANCE--LIGHT REPAIRS	11
SECTION 6: PASSENGER CAR CONSTRUCTION	21
SECTION 7: PASSENGER CAR MAINTENANCE--INSPECTION AND LIGHT REPAIRS.	25
SECTION 8: PASSENGER CAR SERVICE AND SERVICING.	29
SECTION 9: REFRIGERATOR CARS.	33
SECTION 10: SHCHERBINKA TEST LOOP AND LABORATORIES	37
SECTION 11: RAILWAY ENGINEERING INSTITUTE (LENINGRAD).	45
APPENDIX A - MEMBERS OF THE U.S. DELEGATION	A-1
APPENDIX B - RECORD OF PROCEEDINGS OF THE SIXTH MEETING OF THE JOINT AMERICAN-SOVIET RAILROAD WORKING GROUP	B-1
APPENDIX C - U.S. DELEGATION'S ITINERARY.	C-1
APPENDIX D - GENERAL NOTES AND OBSERVATIONS ON NONTECHNICAL ASPECTS OF VISIT.	D-1
APPENDIX E - ENGLISH-LANGUAGE TITLES AND ABSTRACTS OF DOCUMENTS GIVEN TO U.S. DELEGATION BY U.S.S.R. MINISTRY OF RAILWAY TRANSPORT.	E-1

SECTION 1: INTRODUCTION

In August 1977, a U.S. railroad delegation consisting of representatives from both government and private industry (see appendix A) visited the U.S.S.R. This visit was made in accordance with an agreement reached at the fifth meeting of the Joint American-Soviet Railroad Working Group, which had been held in Washington, D.C., in May 1976.

The joint working group convenes annually to review and plan its work on the ongoing railroad technology exchange program, under the U.S.-U.S.S.R. Agreement for Cooperation in the Field of Transportation that was signed in June 1973.

The purpose of the delegates' visit was to familiarize themselves with Soviet rolling stock technology and to participate in the sixth meeting of the Joint American-Soviet Railroad Working Group.

The sixth joint working group meeting, held in Moscow, concluded with the signing of an agreement identifying the work that would be done in the next period (see appendix B).

The delegation visited railroad facilities and other institutions in the Moscow, Kiev, Riga, and Leningrad areas (see appendix C). Emphasis was given to observing practices, procedures, and equipment used in designing, manufacturing, maintaining, and, to some degree, operating passenger and freight cars (including refrigerator cars). In addition, the delegation was afforded the opportunity to tour the railroad test track and laboratories at Shcherbinka, as well as to visit the Railway Engineering Institute in Leningrad and certain ancillary railroad facilities elsewhere in the country.

Throughout the visit, the U.S. delegates participated in numerous meetings and discussions with Soviet railroad representatives, who ranged from the level of gang foreman in a light repair shop to all levels of management, including the equivalent of a U.S. operating vice president. These meetings and discussions were characterized by a free and open exchange of information and views (see appendix D for additional comments on the nontechnical aspects of the visit).

In addition, the Soviet officials furnished the delegation with several books, pamphlets, and technical documents containing a considerable amount of detailed technical information on Soviet rolling stock technology. These documents, all in Russian, are now on file at the Federal Railroad Administration's Office of Research and Development (see appendix E for English-language titles and abstracts).

This report is organized by general topics (rather than as a chronological account of the visit) so as to make the delegation's observations and findings more useful to the U.S. railroad community. Following the introductory

sections (based in part on already published data) devoted to general information and some observations about both Soviet and U.S. railroads, the report presents detailed accounts of Soviet freight car maintenance activities, passenger car construction and maintenance, and refrigerator car manufacture and operations. These accounts include specific observations and assessments made at each facility by the members of the delegation. The report concludes with sections on the Shcherbinka test loop and the Railway Engineering Institute.

The individual members of the delegation contributed to the preparation of this report by providing their notes, general observations, views, and photographs. Their contribution is gratefully acknowledged by the Federal Railroad Administration, as is the assistance provided by Unified Industries Incorporated in the production of the final report.



SECTION 2: OVERVIEW OF SOVIET RAILROADS IN COMPARISON WITH U.S. RAILROADS

In the year 1975, the total tonnage and the number of ton-miles handled by the U.S.S.R. railroads were each 2.5 times greater than those handled by railroads in the United States. The U.S.S.R. Ministry of Railway Transport, which operates all railroads in the U.S.S.R., accomplished this with a freight car complement that was only 75 percent of that of U.S. railroads at the time, using cars with an average carrying capacity that was only approximately 80 percent of that of U.S. cars. It is also worth noting that this freight volume was handled on a system that was only about 40 percent of the length of the U.S. network.

The railroads in the U.S.S.R. have approximately 1.2 times as many locomotives as do the U.S. railroads. In 1975, they manufactured 1.4 times as many new diesel locomotives; if new electric locomotives are included in their production figures, they manufactured 1.8 times the total number of locomotives built in the United States.

The U.S. railroad delegation was informed that 80 percent of the freight cars on the Soviet railroads have been built since 1960. By comparison, approximately 75 percent of the freight cars on U.S. railroads have been built in the past 20 years. In 1975, the U.S.S.R. and U.S. railroads each produced about the same number of new freight cars.

In the U.S.S.R., approximately 65 percent of all intercity freight is transported by railroad (1975); by comparison, 39 percent of U.S. intercity freight moves by rail (the comparable percentages for Western Europe are France, 33 percent; West Germany, 30 percent; Italy, 20 percent; and Great Britain, 19 percent).

The accompanying table provides some selected statistical information on U.S. and U.S.S.R. railroads. While reviewing this table, it should be remembered that the United States has a history of considerable fluctuation in the number of freight cars and locomotives produced from year to year; consequently, single year data as used in this table may not reflect trend lines wholly accurately.

The U.S. railroad delegation learned that, in the U.S.S.R., about 50 percent of the freight car wheels are removed for worn condition and about 50 percent are removed for wheel defects not related to wear.

While visiting the different repair depots on the Soviet railroads, the delegation observed the pattern of wheel wear and was surprised at the small number of wheels removed for worn flange. The delegates were told that only approximately 5 percent of the wheels are removed for this reason. In contrast, railroads in the United States remove two pairs of wheels because of flange wear for every one pair removed because of tread wear. It was further noted that, when Soviet freight cars are placed in the shop for light repair (approximately once each year), the wheel tread is turned if worn to 40 percent of the condemning limit. Since very little evidence of flange wear was noted, the delegation concluded that the frequent turning of the wheels to recontour the tread may be a factor in there being minimal flange wear.

Other factors considered were, for example, the absence of evidence of truck hunting or of pivoting around the center plate; this absence, of course, is related to a lack of flange wear. In the U.S.S.R., truck hunting is normally

U.S. - U.S.S.R. RAILROAD STATISTICAL COMPARISON

		1965	1970	1975
Railroad Freight Movement (billion metric ton/kilometers)	U.S.A.	1,053	1,141	1,256
	U.S.S.R.	1,950	2,495	3,237
Freight Cars in Service	U.S.A.	1,806,000	1,803,000	1,752,000*
	U.S.S.R.	1,030,000	1,140,000	1,338,000*
Locomotives in Service	U.S.A.	30,000	29,000	30,000*
	U.S.S.R.	27,000	29,000	35,000*
Freight Cars Produced	U.S.A.	78,000	66,000	72,000
	U.S.S.R.	40,000	58,000	70,000
Diesel Locomotives Produced	U.S.A.	1,793	1,108	948
	U.S.S.R.	1,485	1,485	1,400
Electric Locomotives Produced	U.S.A.	---	---	---
	U.S.S.R.	641	323	395

*Data for 1974.

Source: Handbook of Economic Status--1976 (EA 76-10481).

associated with empty freight cars operating at speeds higher than the maximum permissible for freight trains. Furthermore, as the delegation observed, the fit between the roller bearing adapter and the freight car truck side-frame permitted about one-half inch of lateral play. It was obvious to the delegation that Soviet railroad track and roadbeds are well maintained and that this high degree of maintenance would tend to reduce truck hunting and associated wheel flange wear.

There were very few mountains in the areas that the delegation visited, and curves were gentle. Freight trains averaging 50 cars in length appeared to be adequately powered to maintain track speed; therefore, there would be very little dragging of the wheel flange on the low rail on curves. There would also be little contact between the wheel flange and the high rail on curves, assuming that the railroads do not operate at over-balance speed on curves.

The members of the delegation agreed that, although there was very little evidence of wheel flange wear, they were unable to determine the exact reason other than that it is most likely a combination of the various factors discussed above. Regardless of the problems inherent in sorting out the cause or causes of the minimal flange wear phenomenon in the U.S.S.R., the delegation concluded that U.S. railroads should familiarize themselves with Soviet experience in this field in the hope of finding the solution to the multimillion-dollar problem of flange wear in the United States.

The Soviet railroads place great emphasis on the preventive maintenance of freight cars. As described in the following sections of this report, all cars are subject to maintenance at fixed intervals, with their component parts being disassembled, inspected, overhauled as needed, and assembled each time.

This system-wide program of preventive maintenance greatly benefits the Soviet railroads. Accidents caused by equipment failures, for example, are very infrequent. Furthermore, as cars are rarely taken out of service for unscheduled maintenance, the railroads are able to sustain a high level of freight car utilization.

Contributing to this high level of utilization are several key factors that are generally beyond the control of U.S. railroads. For example, Soviet shippers are required to load and unload freight cars on very tight schedules. In addition, they are given only very limited choice as to the types of cars they may use to transport their commodities. For instance, a shipper may order a tank car, flat car, open-top hopper or gondola car, or box car, but he is given no choice as to a specially equipped car or a car of a specific tonnage, and he certainly cannot particularize his needs to the point where he would request, say, a pneumatic-unloading covered hopper car. His position is wholly unlike that of his U.S. railroad counterpart, who is able to request and receive highly specialized

equipment designed to transport his products at minimum cost. Nevertheless, as the industrial economy of the Soviet Union expands and becomes more specialized, the Soviet railroads may eventually experience demands for special equipment that will substantially reduce their utilization of freight cars.

The delegation was not able to learn about the cost factors associated with the Soviet preventive maintenance program, nor was it able to determine the economics of either this program or of Soviet car utilization practices in general. It was clear, though, that the Soviet railroads have yet to feel the kinds of economic pressure that result from competition in the transportation industry as it exists in the United States.

Despite the dearth of economic information on the Soviet maintenance program, the delegation members concluded that it would be useful to consider the advantages that would accrue to the U.S. railroad community if it were to implement a comparable program.

There are already indications that the preventive maintenance concept is gaining support in the United States, particularly for application to freight cars that operate at high annual mileages. For example, many U.S. private car owners now schedule cars for preventive maintenance at 2- to 6-year intervals, the cycle depending upon car mileage and the commodity being transported. With the advent of the Freight Car Safety Standard periodic inspection requirements, such practices may be modified, but, even so, they appear to offer some economic advantages. One major private car owner, operating automobile rack cars and cars designed to transport trailers and/or containers, schedules periodic preventive maintenance at 250,000 miles. This program includes attention to trucks and other critical carbody and draft system components.

In addition, some railroad freight cars used in unit train movements are scheduled for preventive maintenance at approximately 200,000-mile intervals. This work includes complete truck disassembly and overhaul, thereby upgrading all components to the functional equivalent of new condition. It is expected that, after several years of experience with this type of preventive maintenance, an economic analysis of the results may well confirm the overall cost effectiveness of performing scheduled preventive maintenance on unit train cars.

SECTION 3: RECENT AND PROJECTED GROWTH OF SOVIET RAILROADS

During the U.S.S.R.'s ninth 5-year plan (1971 to 1975), railroad freight tonnage increased by 30 percent, reaching a total of 3,240 billion metric ton-kilometers by 1975. This total represented more than 50 percent of the world's total annual railroad freight tonnage. During 1971-75, a significant increase in rail traffic flow occurred in the eastern part of the Soviet rail network; this resulted from extensive economic development in the regions of the Urals, Siberia, and the Soviet Far East. During this same period, overall investment in Soviet rail transport increased by 23 percent.

The total length of electrified lines is 39,000 route kilometers. Approximately 40 percent of this total is supplied with alternating current at industrial frequency and 60 percent is supplied with 3,000-volt direct current. More than 99 percent of all train operations and 88 percent of all switching operations are now performed using diesel and electric motive power.

During the 1971-75 period, the Soviet railroads received 375,000 new freight cars, 1.5 times more than during the previous 5-year period, and 15,300 new passenger cars. In addition, container traffic was developed and placed in service during the same time period. The present container fleet numbers 1 million units, including 43,000 high-capacity containers. Container trains now operate between European and Soviet cities, as well as over the Europe-Japan container land bridge by way of the Trans-Siberian Railroad.

During the period 1976 through 1980, passenger-kilometers are expected to increase by 15 percent, after having increased 18 percent in the previous 5-year period, while freight ton-kilometers are expected to increase by 22 percent. In addition, 386,000 more freight cars and 16,600 more passenger cars will be acquired during the 1976-80 period. The 5-year plan calls for the procurement of grain hoppers, which will be eight-axle gondolas with a load capacity of 125 metric tons. Four-axle gondola cars with metal bodies, eight-axle tank cars with a load capacity of 145 metric tons, and passenger coaches 26 meters long rank high on the list of rolling stock to be acquired. A special two-level flat car with a load capacity of 60 metric tons and an empty weight of 26 metric tons will be used to transport automobiles. This type of car will be able to transport 17 small automobiles or 8 of the larger, Volga-type automobiles. The new, large-capacity freight cars will be equipped with improved couplers and a new type of draft gear that will permit impact speeds of 6 miles per hour and the operation of 10,000-metric-ton consists.

The expected increase in freight traffic on the railroads in the U.S.S.R. will be accomplished by mass production of the new eight-axle

gondola and tank cars. The gross weight of a train made up of eight-axle cars is almost 30 percent more than the gross weight of a train of equal length composed of four-axle cars.

During the 1976-80 period, the development of high-capacity container service will require a large number of container-carrying flat cars. This type of car is being built without side walls or a floor, but with the underframe equipped with special mountings for the containers with retractable pins. The car has a gross capacity of 60 metric tons and an empty weight of 22 metric tons. Three 20-metric-ton containers (or six 10-metric-ton containers) can be carried on such a car.

Electrification is one of the most important aspects of technological progress on the Soviet railroads. Under the 1976-80 plan, it will be further developed and a total of 3,500 route-kilometers of railroad line are to be electrified. In addition, a total of 16,000 route-kilometers of railroads will be equipped with centralized traffic control. The plan also proposes to increase freight train speeds from the present 50 miles per hour to 55 miles per hour, and later to 60 miles per hour. The plan also proposes to construct about 3,400 route-kilometers of new railway lines, the main portion of which will be the new, 3,145-kilometer Baikal-Amur Mainline (BAM). Although a few sections will be brought into operation during this period, completion of the BAM railroad is not scheduled to occur until after 1980. In addition to the new rail lines being constructed, roughly 3,400 kilometers of single lines will be double-tracked.

SECTION 4: FREIGHT CAR MAINTENANCE--HEAVY REPAIRS

There are 82 locomotive and car heavy repair plants located on the 28 railroads in the U.S.S.R. These heavy repair plants (and also freight car manufacturing plants) come under the direction of the Ministry of Heavy Construction, rather than the Ministry of Railway Transport.

The U.S. railroad delegation visited the Darnitsa freight car plant, a heavy repair plant located in Kiev. The original plant, built in 1934, was destroyed during the German occupation of Kiev in World War II, but it was rebuilt after the war.

This particular plant is now devoted to the repair of covered box cars and open-top gondola cars, although it also furnishes spare parts to the Soviet railroad system for maintenance and light repair. The plant repairs a total of 11,000 cars per year; about one-third of these are covered box cars and two-thirds are open-top gondola cars. The box cars are scheduled for initial heavy repairs 10 years after being built, the gondola cars 7 years after being built, and both types are brought in every 5 years thereafter.

The standards that have been established for heavy repair of these types of car specify that the cars may not remain at the facility for more than 11 days. The cars are allowed up to 4.4 days on the production line and a total of up to 6.6 days for both waiting to get on the production line and, after leaving the shop, for complete painting and movement off the plant property.

The work is processed through the plant on a production line basis, the lines being moved by "rabbits" every 2 hours, and with two cars located at each spot on the line. The plant operates on a 2-shift, 5-days-a-week basis.

Initially, incoming cars are disassembled in the assembly shop and the components sent to a second shop for rebuilding. Trucks are handled in a separate shop, and the car is finally reassembled in the assembly shop.

The component rebuilding shop overhauls couplers, draft gears, braking systems, friction and roller bearings, various truck components, wheels, and axles, and it also restores worn parts by welding. New roller and solid bearings are supplied by other manufacturing plants. New wheels are produced with a 37-inch diameter and a 3-inch rim thickness (normally described on U.S. railroads as multiple-wear wheels). At this plant, wheels are scrapped if they have less than a 1-inch rim thickness. Wheel life averages 12 years of service on the Soviet railroads, or approximately 600,000 miles.

The cars undergoing heavy repairs at this plant have structural steel sideframes and ends, with wood attached to the steel framing

by nuts and bolts. An average of 380 man-hours are spent in the rebuilding of a four-axle covered box car. During the rebuilding process, no attempt is made to increase the capacity of the car. Only cars specified by the Ministry of Railway Transport are converted from solid bearings to roller bearings, even though the national goal is to have all cars on roller bearings by 1980. The connection between the body bolster and the center sill is given necessary reinforcement in a manner very similar to that used on U.S. railroad cars. The steel side framing and the ends, as well as the top cord angles, are straightened and new wood is installed.

Very few cars scheduled for rebuilding are scrapped after arrival at this plant. However, the U.S. delegation was informed that, if corrosion has extended more than 50 percent into the thickness of the center sill or other main structural member, the entire car is scrapped. The scrap rate for major components on freight cars arriving for rebuilding is approximately 1 percent of the truck sides, 3 to 5 percent of the truck bolsters, and 10 percent of the couplers.

The U.S. delegation observed an excellent production line for fabricating repaired or replacement roofs for the box cars. This line included jigs and fixtures to position the components for the proper welding angle. The delegation also observed jigs and fixtures in the component rebuilding shop to handle couplers and other heavy components for inspection by the magnetic particle process, in addition to welding. However, in the delegates' view, the material handling techniques used there were not as efficient as those used in comparable U.S. railroad shops.

Only a few cars on the production line undergoing heavy repairs are equipped with handbrakes. In response to a question about this practice, the delegation was told that currently designed new cars are equipped with rack-and-pinion-type handbrakes, with the horizontal shaft and vertical wheel mounted low enough that the brake can be operated from ground level at the side of the car. Older cars with a few exceptions, are not equipped with handbrakes, and handbrakes are not installed during the heavy repair cycle.

The draft gears that the delegation observed in this plant appear to be very similar to the low-capacity Miner draft gear that has been used in the United States since the mid-1930's. Later, the delegation learned that is the standard draft gear used on all freight cars in the U.S.S.R. However, the Ministry of Railway Transport is in the process of evaluating higher capacity draft gears to be used on new eight-axle cars having a capacity of 125 metric tons.

The standard coupler used on Soviet railroads appears very similar to the early U.S. design known as Willison. This coupler has a gathering

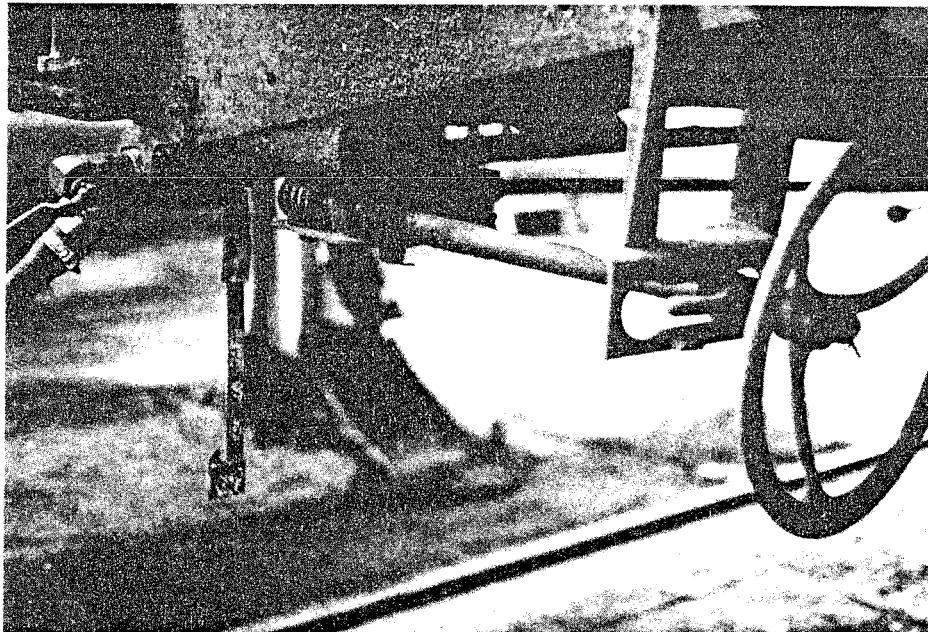


Figure 1. A modern freight car equipped with the type of handbrake that will soon be standard on cars in the U.S.S.R. railroad system. The horizontal shaft of the brake is moved to the left to engage the rack and pinion and apply the brake; the brake is released by moving the shaft to the right.

range very similar to the Association of American Railroads standard couplers and is operated in a similar fashion. The U.S. delegation was informed that an improved coupler would be required for the eight-axle high-capacity cars, but that the existing design would continue to be used incorporating a higher strength or alloy steel casting.

The evidence observed by the U.S. delegation at this plant in regard to standardization of components on Soviet railroads was confirmed by visits to other Soviet facilities. From an inventory standpoint, there are obvious advantages in using such standardized freight car components as 37-inch diameter multiple-wear wheels and standardized roller bearings, couplers, and draft gears. However, the disadvantage of this rigid standardization is also obvious, especially in the highly specialized Darnitsa freight car plant, which repairs only box cars and open-top gondola cars. The continuing demand to handle additional tonnage has resulted in the introduction of the eight-axle, 125-metric-ton car, which requires higher-strength couplers and draft gears with increased capacity. If these improved components are restricted to eight-axle cars, it would appear that these cars will have to be operated in solid consists and that existing cars will have to be excluded from such consists.

Because of the problems that could be expected in this situation, there appears to be good reason for management at all levels to

resist any change in existing standards. Any change upsets production goals, particularly semiautomated types of production, and all levels of management are evaluated in terms of being able to meet their production goals.

Computers are used to control inventory in this plant. Currently (1977), they are what is termed second-generation computers. This plant has now received two newer generation computers, but they are not operational yet. During the U.S. delegation's visit to various facilities on the Soviet railroads, the members noted frequently that when computers were discussed there appeared to be a great deal of enthusiasm on the part of Soviet officials, but there was very little evidence of practical use of computers. It would appear that computer technology on the Soviet railroads will eventually improve, but that present Soviet technology is at a stage comparable to that on the U.S. railroads in the early 1960's.

In addition to repairing cars, this plant also includes facilities for the manufacture of spare parts for the Soviet railroads. Included in these facilities is a small foundry that casts parts weighing up to 100 kilograms.

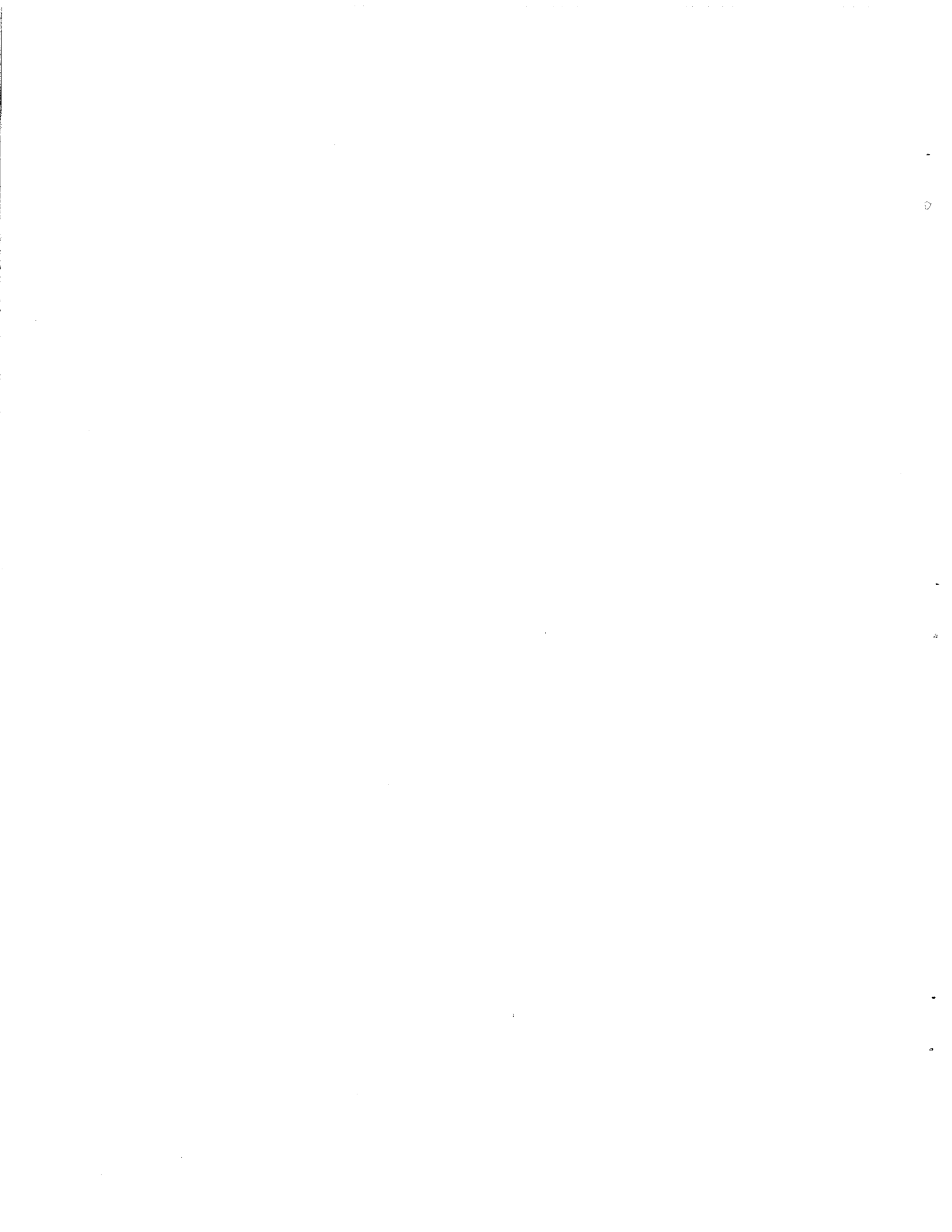
The U.S. delegation noticed the plant does not have any facilities for heat treatment, either in the rebuilding or truck repair shops. Furthermore, throughout its visit to the Soviet Union, the delegation failed to see any indication that heat treatment is used.

The Ministry of Railway Transport periodically sends a group to inspect this plant for quality control and to see that the work conforms to the government standards for this type of repair work. Currently, there is a program to reduce the number of people employed in the quality control function. Experienced personnel who have demonstrated their ability to perform high-quality work are given a special designation, which means that their work does not require additional quality control inspection. The workers who receive this special designation also receive incentive bonuses ranging from 5 to 10 percent of their base pay. Welders and torch cutters also receive a salary slightly higher than the conventional mechanic's salary.

During a general discussion with the plant director and his assistants, the members of the U.S. delegation learned that a major portion of the director's time and that of his immediate management team was devoted to "people" problems and that the operation of the plant came under the general direction of the director's technical assistants.

There are approximately 3,000 people employed at this car repair facility, which covers about 15 acres. In addition to the car repair shops, the facility also includes housing, stores, two middle schools, four kindergartens, a stadium (built by the workers), and a 700-seat hall for the employees. In addition, the facility has a camp for children and a rest area for the workers.

In response to a question concerning the type of workmen employed, the U.S. delegation was informed that there are approximately 400 welders, 100 cutters, 600 fitters and plumbers, 100 carpenters, and approximately 130 supervisory and quality control people at the facility. It was obvious that, in addition to plant maintenance personnel, a large percentage of the work force is employed in the maintenance and operations of the schools, apartments, and stores furnished for the workers.



SECTION 5: FREIGHT CAR MAINTENANCE--LIGHT REPAIRS

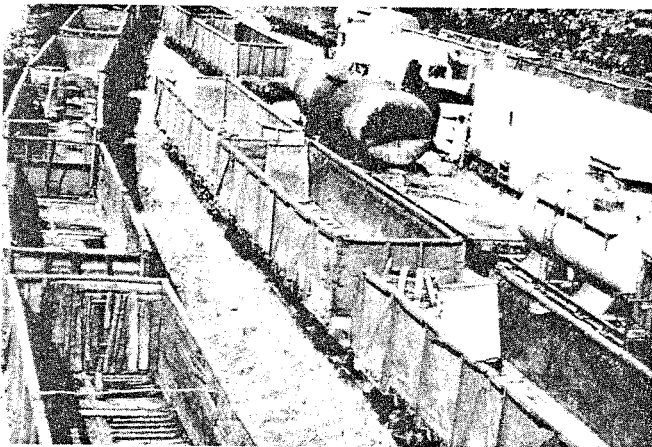
In Leningrad, the U.S. delegation visited a freight car repair depot, which is one of four such depots on the October Railroad that repairs open-top hoppers and gondolas. (The delegation was unable to determine the number of other depots on the October Railroad that repair closed cars, tank cars, flat cars, etc.) Located adjacent to a classification yard, the Leningrad repair facility was built in 1934 and refurbished in the mid-1960's. Its principal function is to perform scheduled repairs on freight cars.

Freight cars on the Soviet railroads system are not assigned to particular railroads. Rather, they are used by all railroads in a manner similar to the interchange system on U.S. railroads. When they are due for scheduled repairs, Soviet freight cars are routed to different depots specializing in the repair of different types of car.

The date of the last scheduled repair on a car is stenciled on the car itself, and any car overdue for repairs is reported by the inbound yard car inspector. The railroad is notified as to which cars are due for scheduled repairs. The railroad selects the cars to be repaired at a particular depot and sends the remaining cars to other depots.

The scheduled annual repair consists of removing and disassembling trucks; cleaning and repairing truck components, wheels, axles, and roller bearings; removing coupler, draft gear, and yoke; removing air brake valves, slack adjusters, and brake cylinders; and straightening and performing necessary repairs to the car body, including replacing wood sides and ends.

The Leningrad repair depot specializes in open-top hopper cars and gondolas, each of which is scheduled for maintenance every 12 to 14 months. The scheduled repairs at the depot average about 34 man-hours per car and about 6.3 cars per man-month (excluding medical and other support people).



A small portion of the work performed at this depot is for unscheduled repairs, or running repairs, which result from defects found during inspection. The depot also performs uncoupled repairs, or trainyard repairs, on specified tracks in the yard if it is not necessary to bring the car to the depot.

At the Leningrad depot, which employs a total of 1,200 people (including management and support personnel), there is an assembly shop that works two shifts and component repair shops that work either one or two shifts as needed. The assembly shop consists of two tracks, each of which holds seven cars. Cars are disassembled on the inbound side. About halfway through the assembly shop, the trucks are transported laterally to the component repair shops that specialize in trucks, wheels, axles, and roller bearings. The first operation on the truck after it enters the component repair shops is cleaning both the truck and its components. The truck is then disassembled and the roller bearings are removed, cleaned, inspected, and repaired. The wheels are turned if they are worn more than 40 percent of their condemning limit. After cleaning, the bolsters and sideframes are inspected for cracks, using magnetic particle inspection techniques for critical areas. The high-stress areas of the sideframes receive a white coating (similar to a stress code) that is effective in showing stress cracks that develop after the vehicle is returned to service. The trucks use a hanger-type brake beam. Vibration-caused hanger wear is reduced by using a grommet between the hanger and the truck side; this grommet is renewed when the truck is disassembled.

In addition to observing the above-described operations, the U.S. delegation toured a small machine shop, a welding shop, an inspection shop where magnetic particle inspection and other nondestructive testing are performed, and a shop that repairs the end doors on gondola cars utilizing a hydraulically operated jig and fixture for straightening the doors.

Figure 2. Open-top hoppers and gondolas waiting to enter the shop for annual inspection and light repair. The tank car, which shows evidence of derailment damage, is being used as a stationary tank for the storage of shop supplies. This was the only evidence of derailment damage observed by the U.S. delegation during its entire tour of U.S.S.R. railroad facilities.

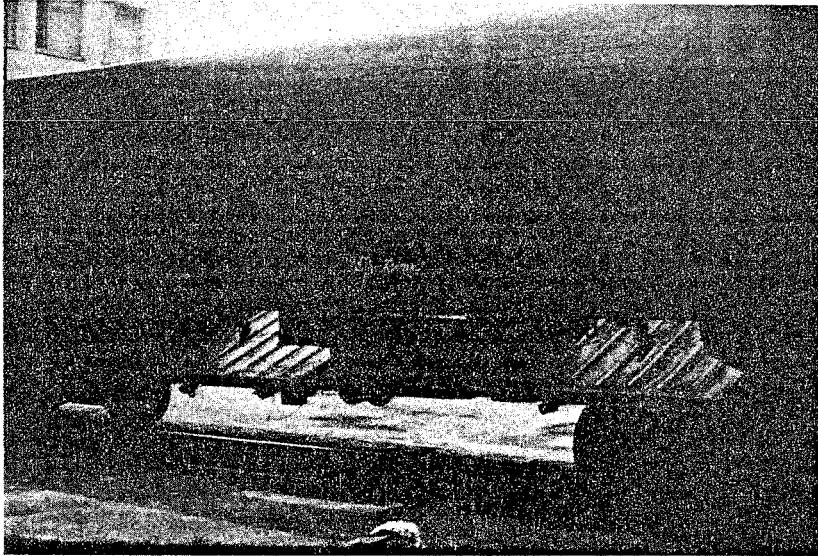


Figure 3. Hopper car gates are hinged at the center sill and latched at the side sill. When opened, they discharge the load on both sides of the track.

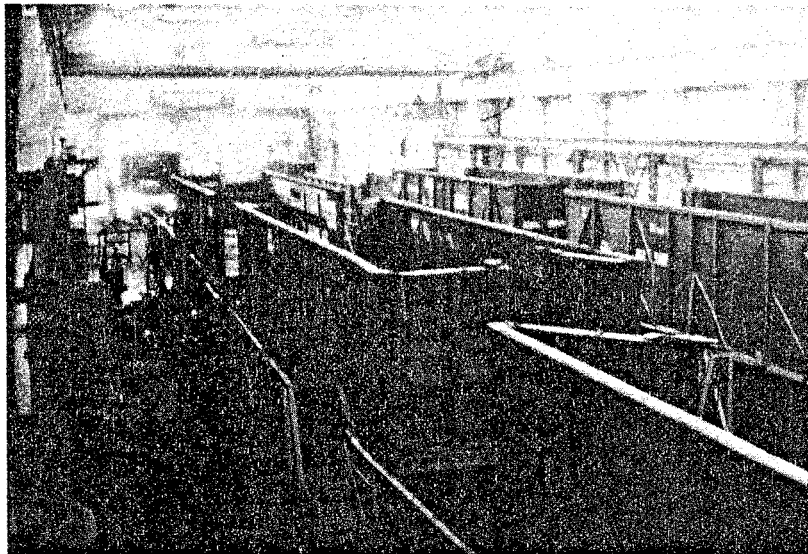


Figure 4. Gondola cars in the shop undergoing light repairs. Components are removed in the near section of the shop and reapplied at the far section. Trucks are removed in the center section of the shop.

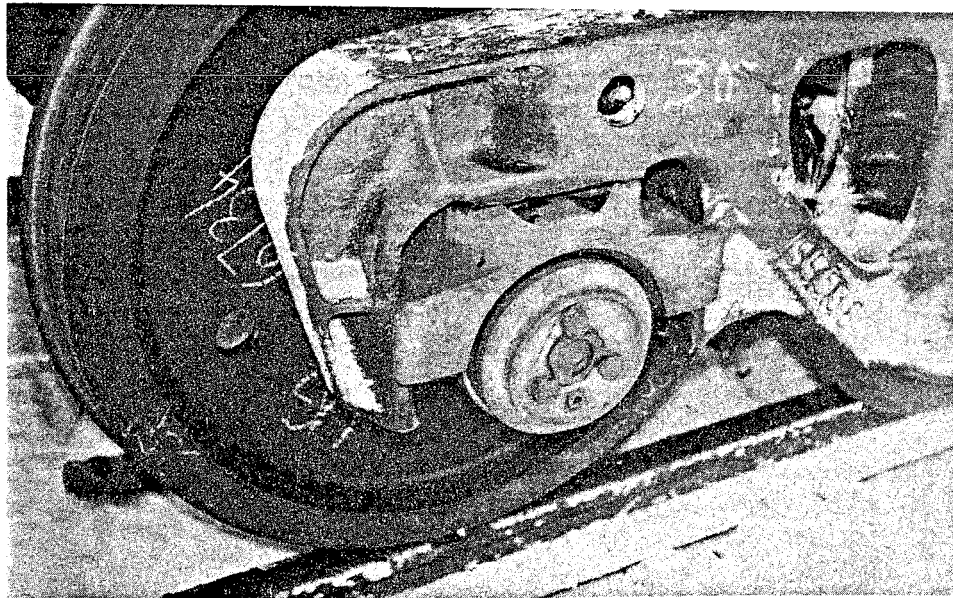


Figure 5. Freight car roller bearing typical of those used on railroads in the U.S.S.R.

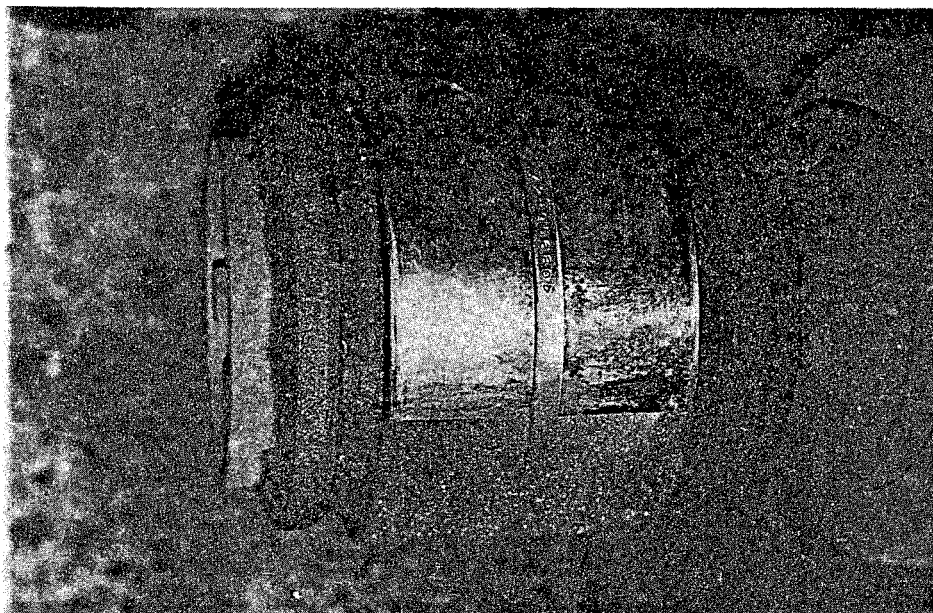


Figure 6. Side view of freight car roller bearing.

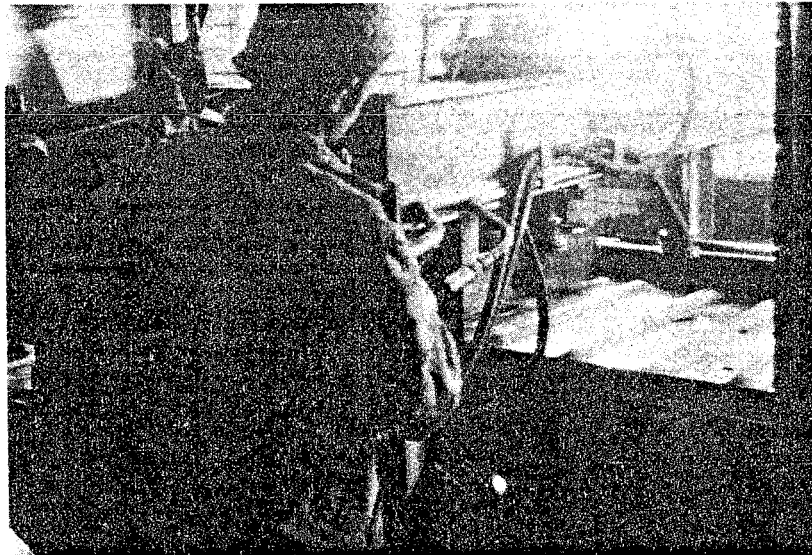


Figure 7. The end doors of gondola cars and hopper discharge gates are straightened on a production line basis using a hydraulic press positioned by this operator.

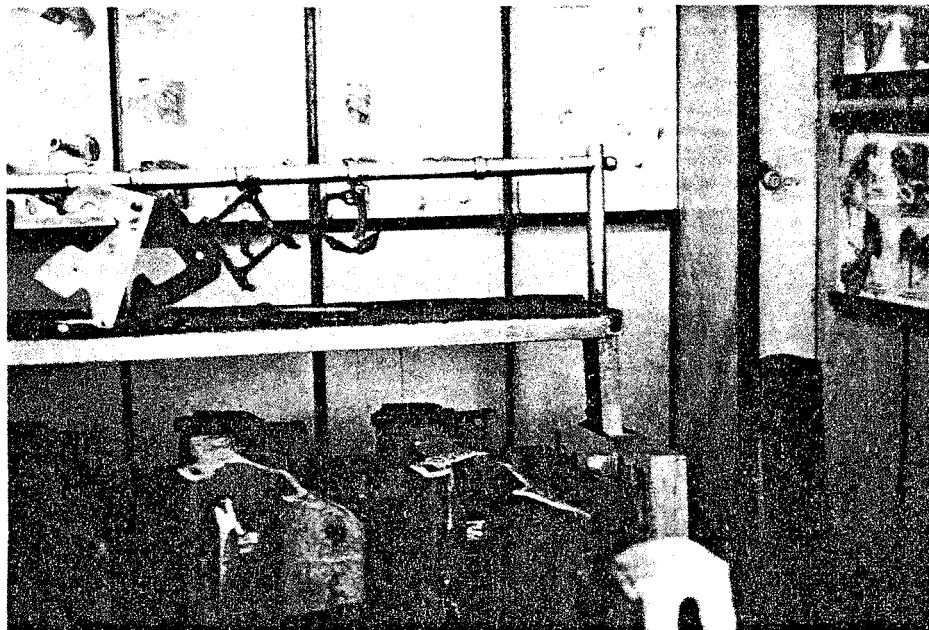


Figure 8. Eight couplers are mounted in this fixture, which can rotate them 90 degrees to the right or left for inspection and reapplication of such components as lock lifters and knuckles.

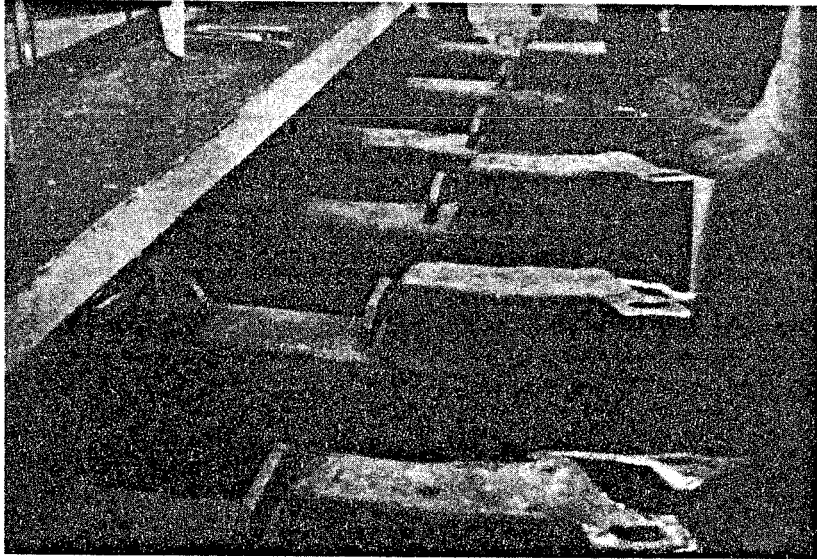


Figure 9. Details of rotational fixture for inspection of couplers and reapplication of components.

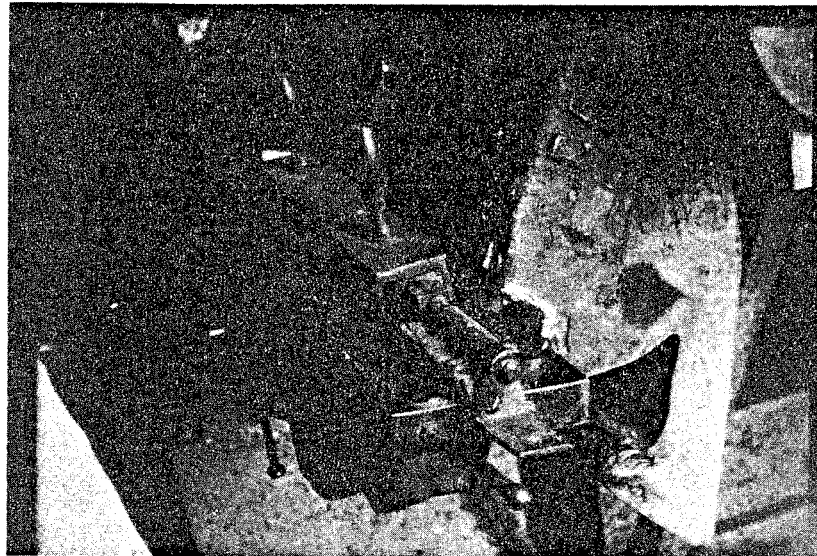


Figure 10. A coupler mounted in the fixture where steel plate, cut to proper size, is fuse-welded to restore worn areas.

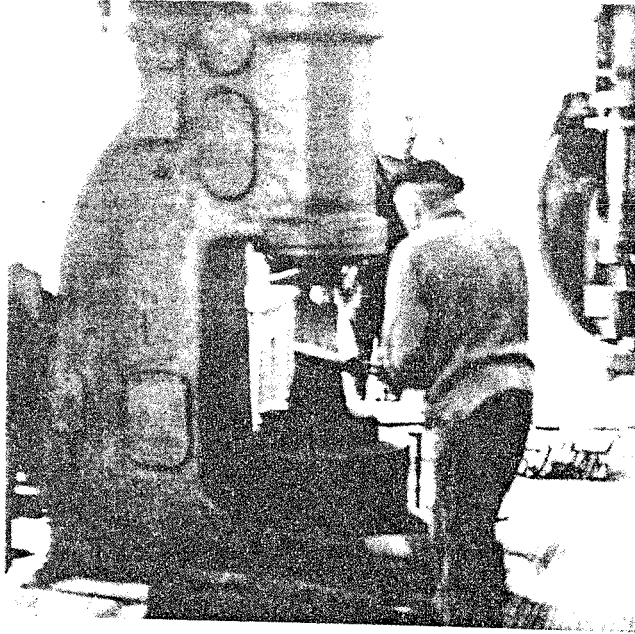


Figure 11. Restoring a worn component at the Leningrad freight car repair depot.

An observed coupler appeared to be very similar to an early U.S. coupler (the so-called Willison design) and weighs approximately 200 kilograms. It has a gathering range of 4 inches in the vertical direction and slightly in excess of 7 inches (common in the standard U.S. coupler) in the horizontal direction. The coupler used on Soviet railroads incorporates a "weak link" in the knuckle operating mechanism that will break in the event of excessive tensile force and open the coupler. This is similar to the design of the coupler used on U.S. railroads. The U.S. delegation was informed that, even in mountainous terrain, the Soviet railroads do not experience undesired train partings caused by excessive tensile force.

Areas of wear in the coupler are restored by applying weld metal, followed by machining. In the repair of one major area of coupler wear a 12 gage steel plate approximately $1\frac{1}{2}$ inches by 10 inches is applied and fuse welded to the worn area. This pressure fuse welding is done in a manner similar to the submerged arc process and appears to be very successful.

The air brake valve, piston, brake cylinder, and end hoses are removed, checked, and tested in separate locations, as is the automatic slack adjuster. All repaired components are thoroughly tested after being installed on each car and before the car is released from the shop.

The support shops visited by the delegation were equipped with jigs and fixtures to facilitate the inspection and repair of components.

Wall-mounted charts under glass at the work stations gave all pertinent dimensions for condemning limits and restoration of worn parts, as well as detailed instructions for disassembling and reassembling the components.

The delegation conferred with depot personnel about their operating practices and light repairs performed on freight cars on the October Railroad. They explained that, prior to dispatching a train from the yard, there is a very thorough inspection of air brakes on each car to insure that the brake system operates properly. This practice is quite similar to the U.S. railroad practice of initial terminal inspection of train brakes. The officials also said that winter operation in the Leningrad area presents no particular problems relating to equipment; however, they admitted that the severe cold weather (down to minus 50 degrees C) does reduce the workers' productivity.

After leaving this depot, the delegation walked across a pedestrian bridge over the classification yard hump and observed the humping operation. The speed of humping appeared to be comparable to that customary in U.S. yards. The delegation noted with interest that farm equipment loaded on flat cars was secured with a minimum number of blocks under the wheels and very few strands of wire at each end. It was evident that overspeed impacts do not occur in the trainyard and that in-train longitudinal forces must be substantially less than those found on the U.S. railroad system.

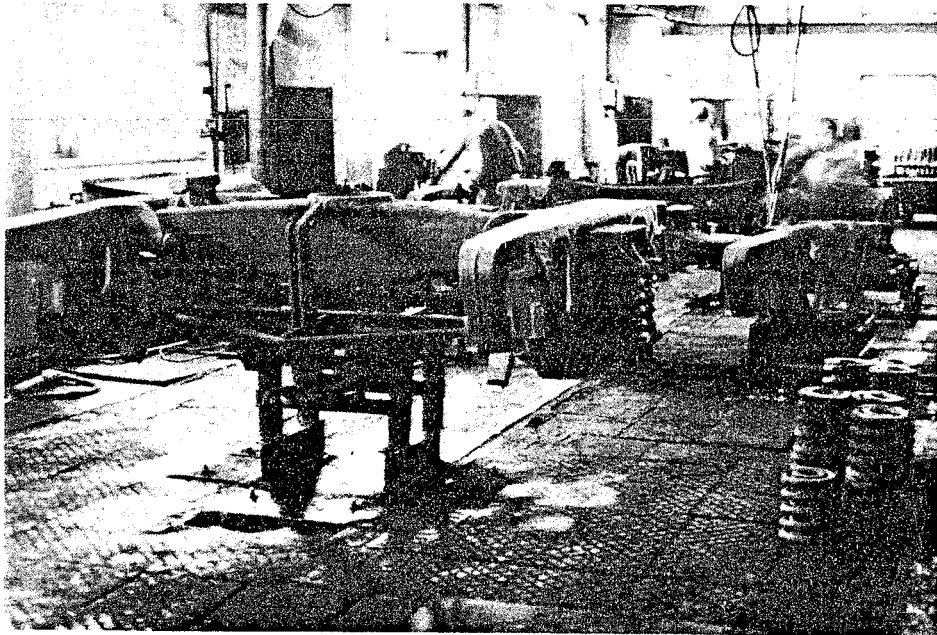


Figure 12. Freight car truck and coil spring nest using 7 inner and outer coils. This truck design is quite similar to that of the Barber S-2 truck used in the United States.

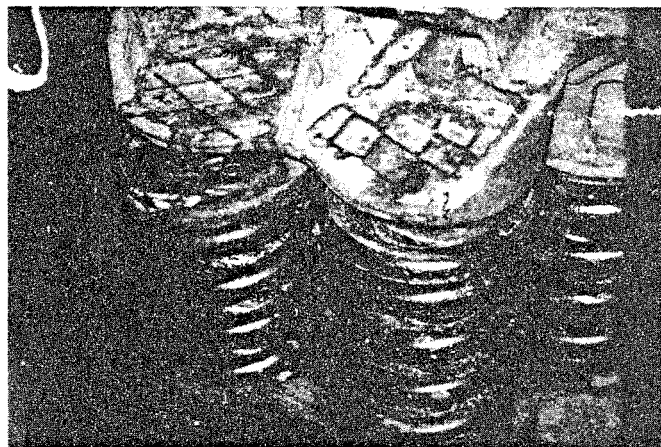


Figure 13. Closeup of the freight car truck shown above.

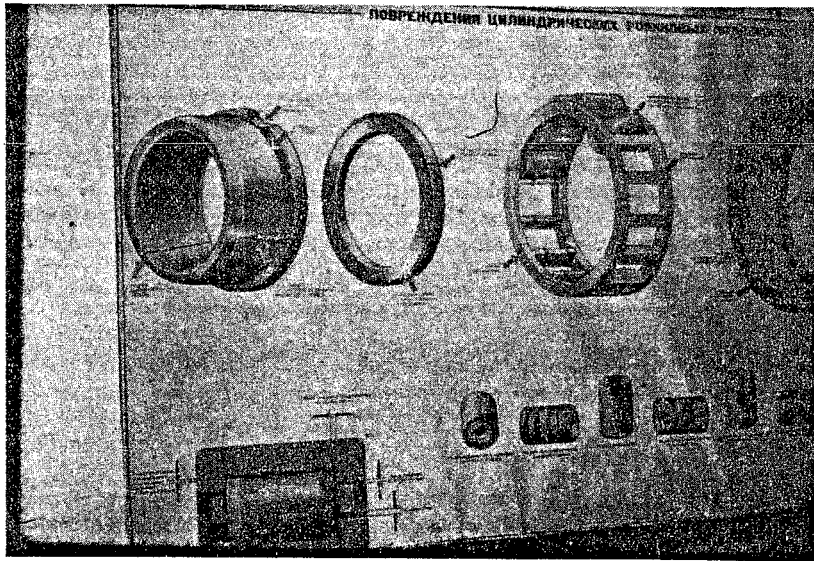


Figure 14. Wall chart mounted above the work area shows the proper procedure for inspecting roller bearing components.

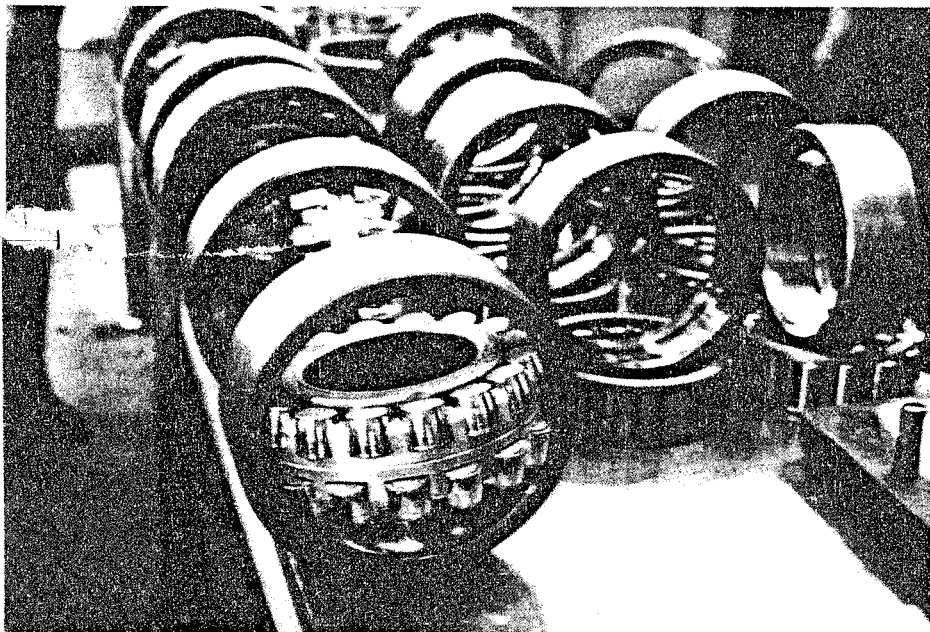
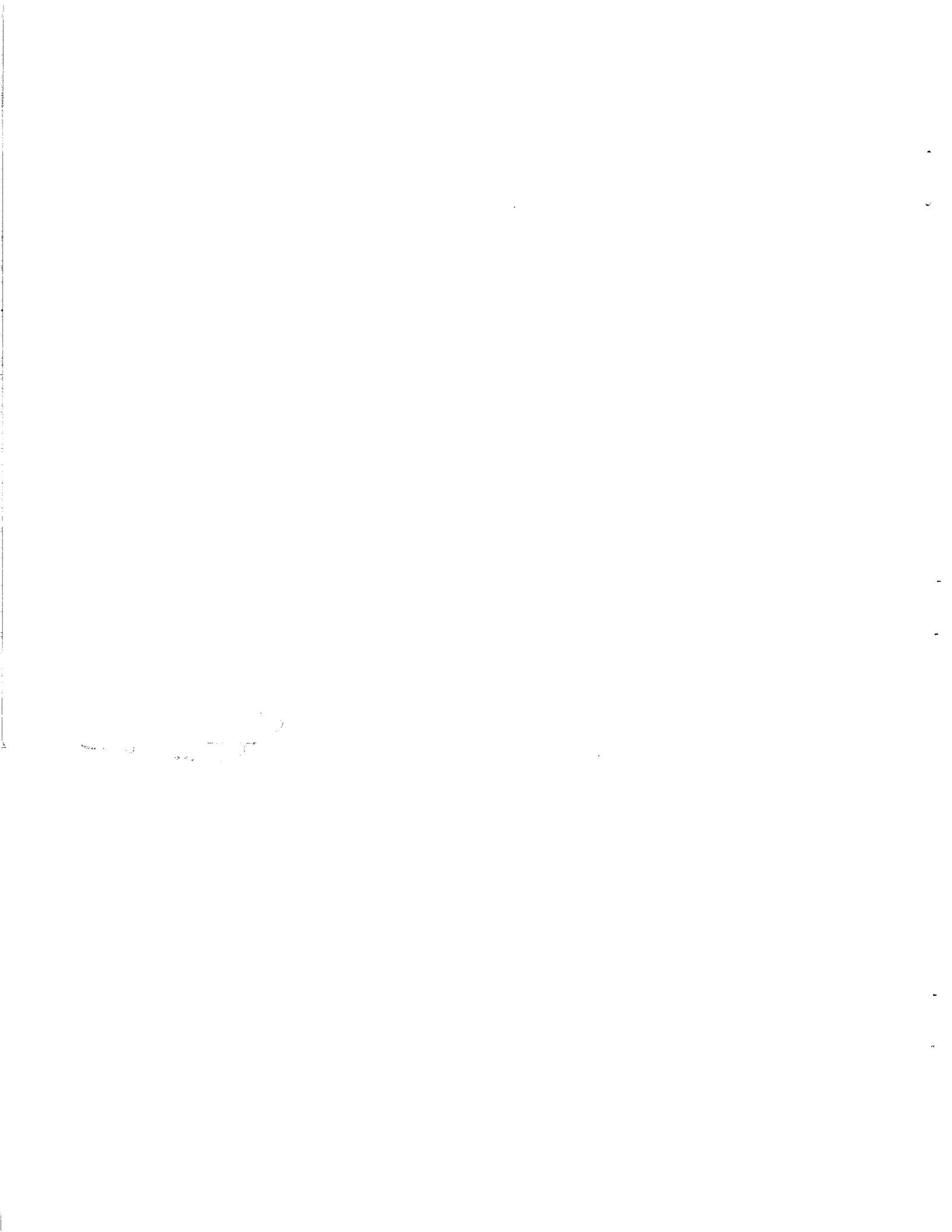


Figure 15. New and old style roller bearing components used on freight cars. The roller bearing was formerly mounted on the journal with a slip fit; however, an interference fit is now used. The end of the journal is threaded and a large nut is used to retain the roller bearing on the journal.



Figure 16. A cut of cars approaching the crest of the hump at a classification yard in Leningrad.



SECTION 6: PASSENGER CAR CONSTRUCTION

The Riga passenger car manufacturing plant, located at Riga on the Baltic Sea, dates from around the turn of the century. Initially, it manufactured freight cars and other components, but, after World War II, it was enlarged to include the manufacture of electric rolling stock. In 1956, it designed and manufactured its first train, which was designated ER-2. In 1962, the Car Research Institute, a branch of the All-Union Diesel Locomotive Research Institute, was established at the Riga plant; its purpose was, with the help of its parent research institute, to design and test the new equipment manufactured at the plant. In 1963, the plant developed a diesel train and began manufacturing light rail vehicles, such as street cars.

Currently (1977), the facility has two major design groups -- one for developing cars for electric trains and street cars and the other for developing cars for diesel trains. As the U.S. delegation learned during its visit to the plant, the actual demand for passenger equipment on Soviet railroads is higher than was originally projected, and this plant is in the process of remodeling to increase its productive capacity. When remodeling is completed in 1982, the capacity of the plant will be doubled (it is scheduled to produce 680 passenger cars in 1977). It is estimated that this will cost approximately \$45 million in capital investment, with the work to be completed without interference with the plant's ongoing production.

The plant, which operates two shifts a day 5 days a week, employs 5,300 people at the present time (1977). The design and engineering test group employs approximately 500 people; of these, 200 are engaged in the design of electric passenger trains and street cars, 135 in the design of diesel-powered trains, and 180 are classified as technologists. Tests are performed on new equipment in the plant, as well as on the railroad line with recorder-equipped test cars, and the results are analyzed on computers.

After a brief tour of the manufacturing facilities, the U.S. delegation visited the research facility, which has the capability for compression testing of an entire passenger car, subjecting it to approximately 750,000 million pounds of longitudinal stress. This facility also has the capability for fatigue testing various truck components.

The Riga plant produces ten-car electric traction units, which are designed for commuter operations. Each car, which costs about \$57,000, can carry 110 passengers. About 12 inches wider than U.S. passenger cars, these Soviet cars appear to be very functional.

The manufacturing plant is currently in the process of completing an order for 200 electric cars to be delivered to Bulgaria, and it has signed a \$20 million contract with Yugoslavia for cars that are to be delivered by 1981. It was evident to the U.S. delegation that the plant personnel involved in the design and production of passenger cars expect an increase in demand for this type of equipment. They believe that the increase in fuel costs will result in increased use of electric trains. They noted that, on a good summer's day in the Riga area, the railroads transport 600,000 people to the Baltic seashore. The low fare (approximately 35 cents) on this 45-minute train ride, is indicative of a predominant factor in the increased volume of railroad passenger traffic in the Soviet Union. Normally, long-distance railroad fares average 1.6 cents per passenger-mile, whereas air fares average 2.6 cents per passenger-mile.

Various models of electric and diesel passenger trains are designed and manufactured at this facility. At the time of the U.S. delegation's visit, a recently designed train set, designated ER-200, was ready to go into service and operate at speeds up to 125 miles per hour. This equipment has an aluminum carbody, pneumatic suspension system, disk brakes, and automatic

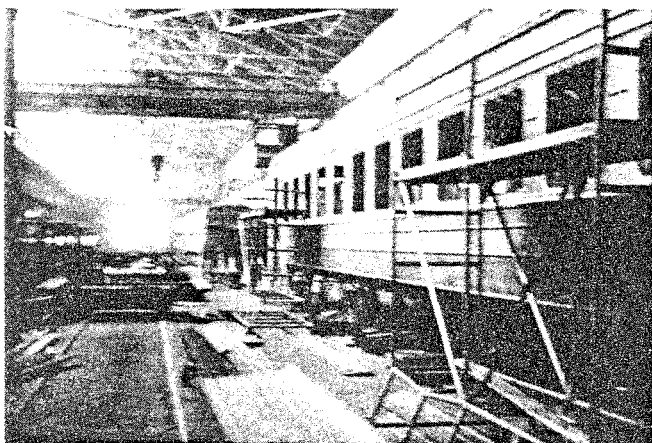


Figure 17. New passenger car construction.

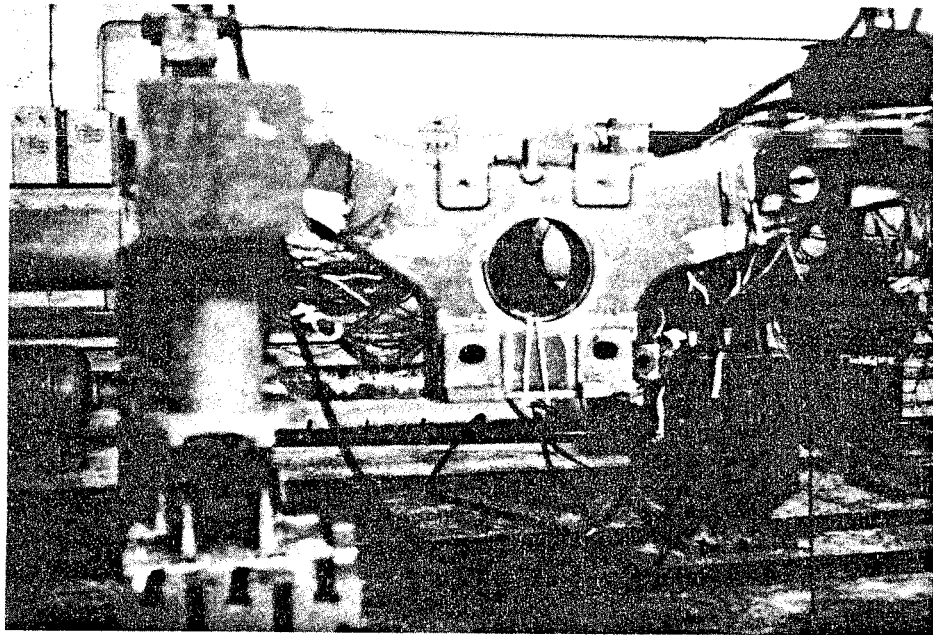


Figure 18. Passenger car truck ready for fatigue testing with strain gages.

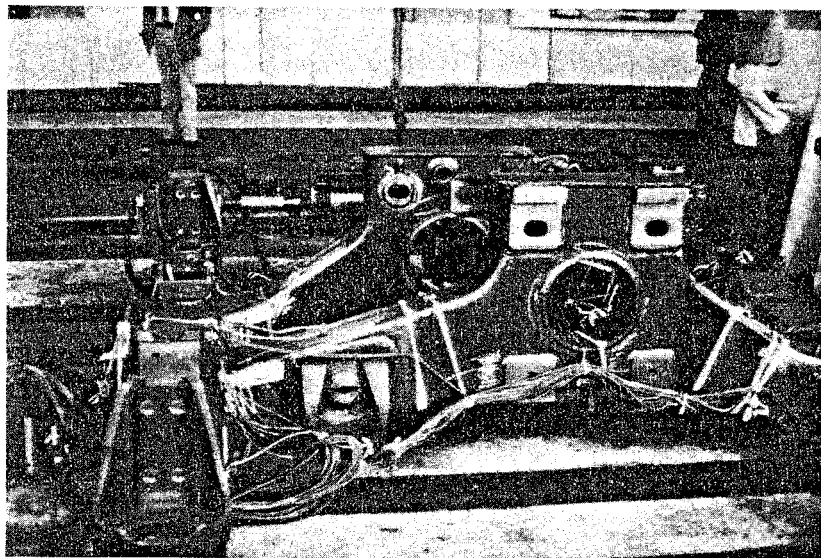


Figure 19. Closeup of passenger car truck ready for fatigue testing.

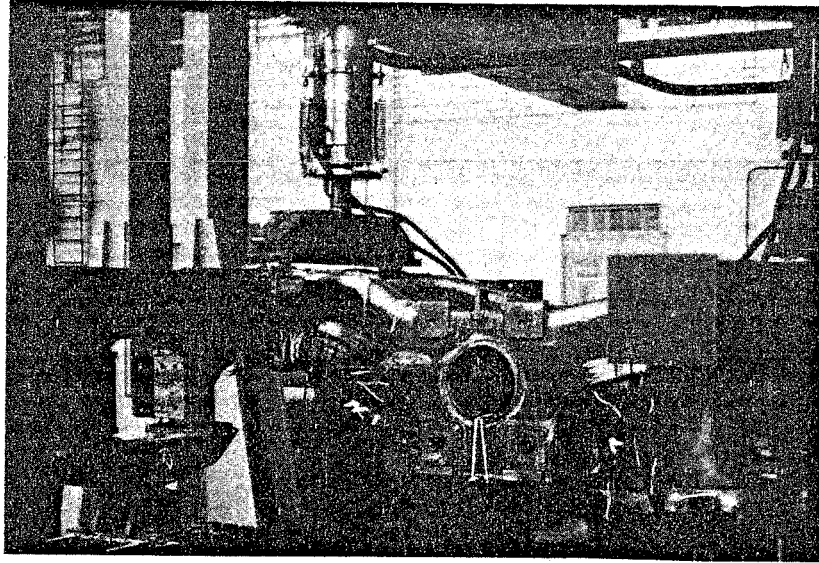


Figure 20. A passenger car truck undergoing fatigue testing.

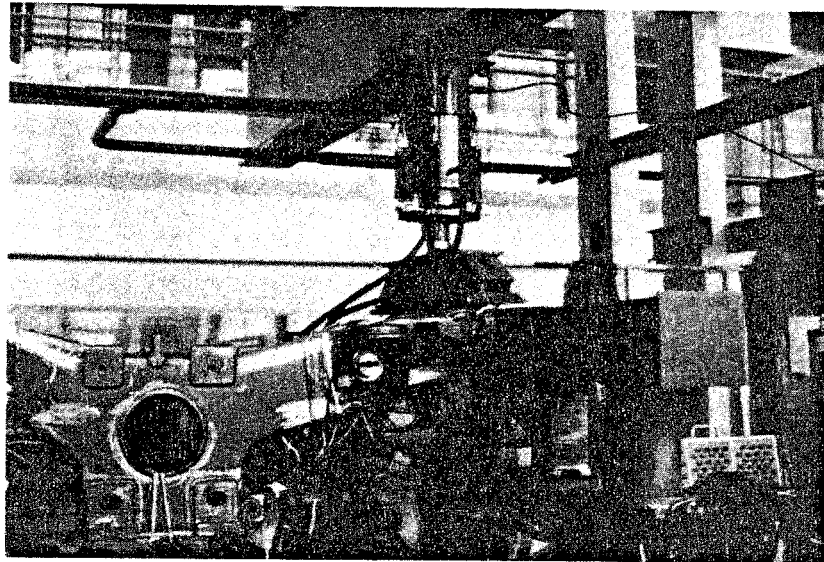


Figure 21. Fatigue testing a passenger car truck.

train control, with an interior similar to that of a passenger aircraft. The cost of one of these cars is expected to be approximately \$350,000.

The passenger car trucks, as well as some locomotive trucks that were observed by the delegation, are of fabricated rigid design. The truck sides are fabricated in two halves and joined together with high-quality welding. The primary suspension consists of coil springs located adjacent to the roller bearing axle boxes. Other fabrication and subassembly work appeared to be well organized and well managed. The delegation noted that modern material handling techniques were lacking; however, this shortcoming may be corrected in the plant's planned modernization program. The delegation left this facility with the impression that it was one of the largest passenger car manufacturing plants in the U.S.S.R., and was favorably impressed with its overall management and its research and development section.

The delegation also visited the Yegorov car manufacturing plant, located in Leningrad. In use as a car manufacturing plant since the turn of the century, this plant built its first subway cars in 1968 and is now scheduled to be devoted entirely to the building of subway cars. Currently (1977), about 50 percent of its production (in terms of cost) consists of subway cars, with the remainder being composed of inter-city passenger cars, baggage cars, and mail cars. This plant is one of two plants in the Soviet Union that manufactures subway cars at this time.

The plant, employing 2,200 people, is the smallest passenger car manufacturing plant in the country. It customarily operates only one shift. A shortage of workers limits its ability to operate the required support facilities, such as the machine shop, for more than one shift. However, special arrangements may be made for a second shift when needed to maintain production.

The U.S. delegation concluded that the machine shop was manufacturing many components that in the United States would be purchased from a major component manufacturer. For example, the delegates observed the machining of air brake pipe brackets and common nuts and bolts.

During a tour of the foundry shop, the delegation noted that aluminum die castings and aluminum extrusions were being produced. The delegates were told that two of the machines in this shop came from Italy and the remaining ones from Czechoslovakia. The plant produces aluminum conduit fittings and gratings for air deflectors used on subway cars manufactured at this plant and at other plants.

The subway car assembly plant consists of one track with four spots at which cars are assembled from such subassemblies as underframes, sides, ends, and roofs, which are manufactured at other locations in this plant. The subway car weighs about 70,000 pounds when

completed, and it is very similar to the modern subway cars being produced in the United States. The automatic coupler is similar to the Chicago Transit Authority coupler manufactured by the Ohio Brass Company. The electrical and pneumatic connections are made at the time cars are coupled. The traction motor is connected to the axle through a gear reduction box that is very similar in design to that currently used in the United States.

This plant consists of small buildings, so it is necessary to use a transfer table from the primary assembly line, where the outer shell of the subway car is completed, to a secondary assembly plant where the car is finished. When subway cars are completed, they are transported by rail with adaptor cars in order to change from the automatic coupler connection to the conventional railroad coupler.

It was the consensus of the U.S. delegation that this plant was not among the most efficient facilities observed during the visit to the Soviet Union.

SECTION 7: PASSENGER CAR MAINTENANCE--INSPECTION AND LIGHT REPAIRS

In the Soviet Union, passenger cars are assigned for maintenance and operation to specific railroads. The cars assigned to the 3,600-mile-long Baltic Railroad are serviced and repaired at the passenger car light repair depot in Riga. At this depot, as at similar depots elsewhere on the Soviet railroad system, each passenger car is given a technical inspection once each 6 months and a somewhat more rigorous technical inspection once each year.

The light repair depot receives a monthly schedule of cars due for inspection, with three cars being scheduled for technical inspection each day. Each car is stencilled with the type, date, and location of the last scheduled inspection that was completed. If the stencil indicates that a car is overdue for a 6-month or annual inspection, the car has to be removed from service. Every fourth year, each car is sent to a major overhaul shop, where both its interior and exterior are completely refurbished.

At the time a passenger car receives its 6-month inspection, it is detrucked and the truck disassembled for inspection of the individual components. The coupler, yokes, and draft gears are removed, and, after proper inspection and cleaning, necessary repairs are made. After the wheel sets have been removed and cleaned, the axles are magnefluxed and ultrasonic inspection is performed on the axles under the wheel seat. As with freight cars, if the wheel tread on a passenger car is worn to more than 40 percent of the condemning limit, it is turned to a new contour. The U.S. delegation noted that this contour appears to be very similar to a new profile recently introduced on Canadian National Railways.

The scheduled annual inspection for passenger cars is a more detailed procedure than the 6-month inspection. For example, during its annual inspection, a car routinely spends 5 days in the shop, during which time its exterior is painted and major rotating electrical equipment is replaced.

The main shop where technical inspections are performed consists of a modern brick structure. The assembly shop therein has three tracks, each of which can accommodate two passenger cars. In addition to the assembly shop, the main shop includes support shops devoted to the inspection and repair of trucks, couplers and draft gears, electrical equipment, wheels, axles, and bearings, and also a paint shop. The delegation was informed that about 5-6 percent of the repairs performed in the 200-man technical inspection shop are of an emergency nature rather than scheduled maintenance.

The technical inspection shop also houses a 20-seat classroom devoted to training and safety. One wall of the classroom contains displays of safety rules that the instructor can illuminate by remote control. The classroom also contains models to help demonstrate how certain machines operate. The model that was demonstrated during the U.S. delegation's visit displayed schematically the electric current flow in a welding machine. All new employees are given safety instructions in the classroom, but there is no set schedule for attendance by regular workers. During the 5-year period from 1971 to 1975, the delegation learned, a total of \$2.8 million was invested in labor safety and training at this repair depot.

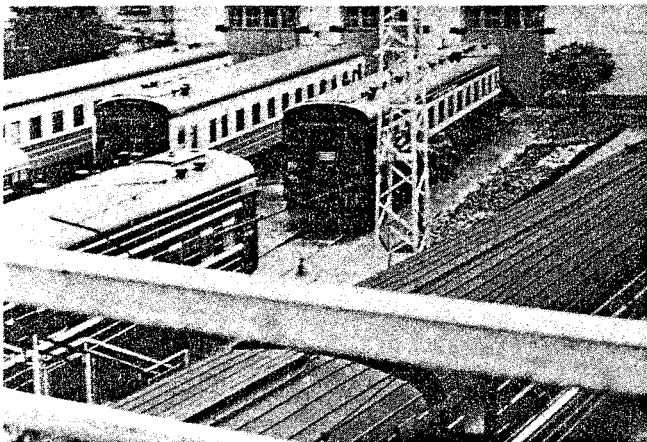


Figure 22. Passenger cars ready to enter the light repair depot for scheduled inspection.

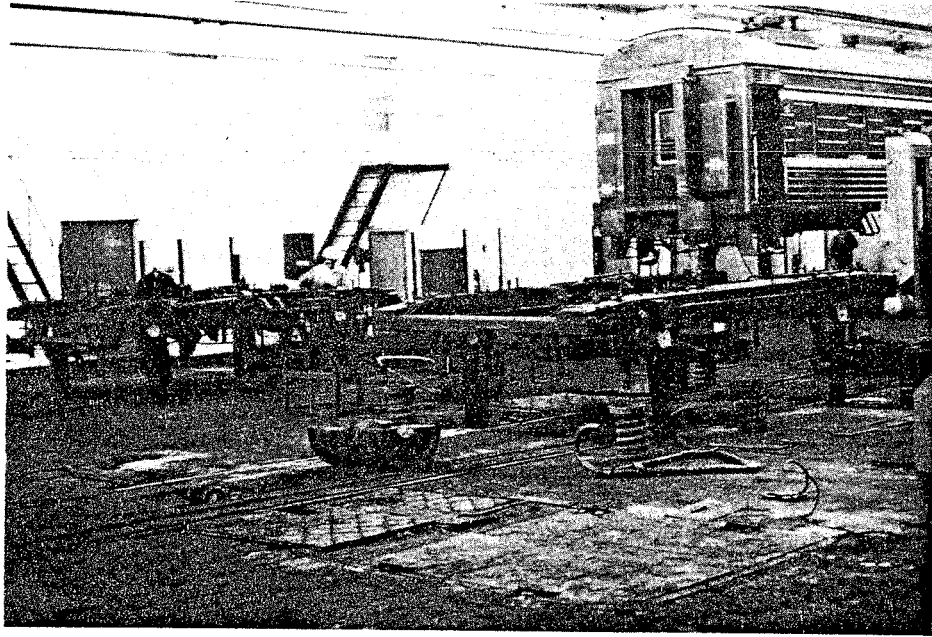


Figure 23. Passenger car in the light repair depot at the work position where the trucks are changed.

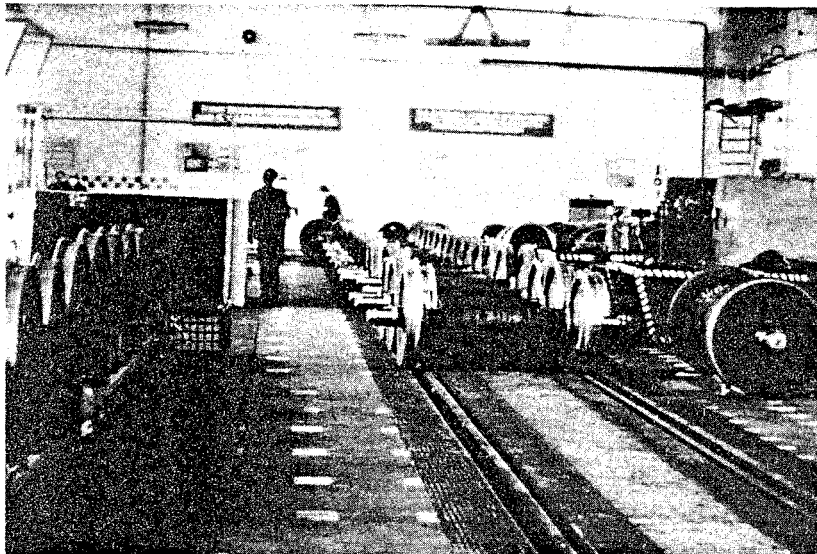


Figure 24. The wheel shop at the passenger car light repair depot.

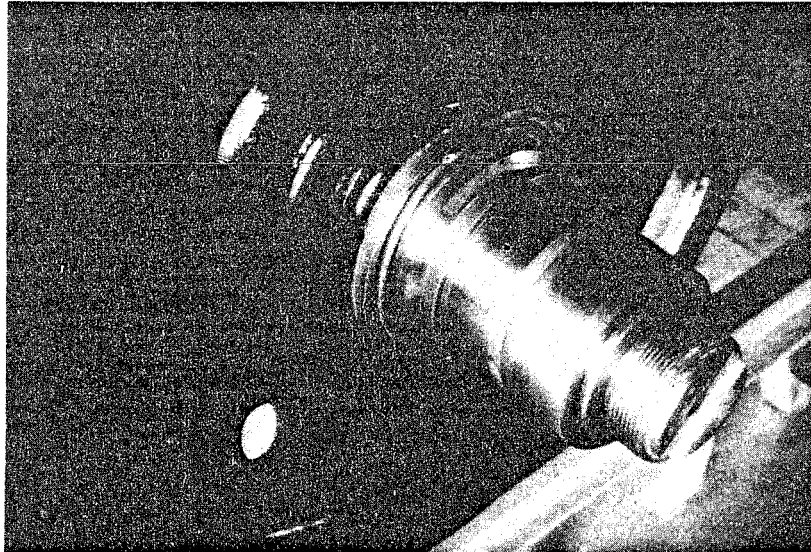
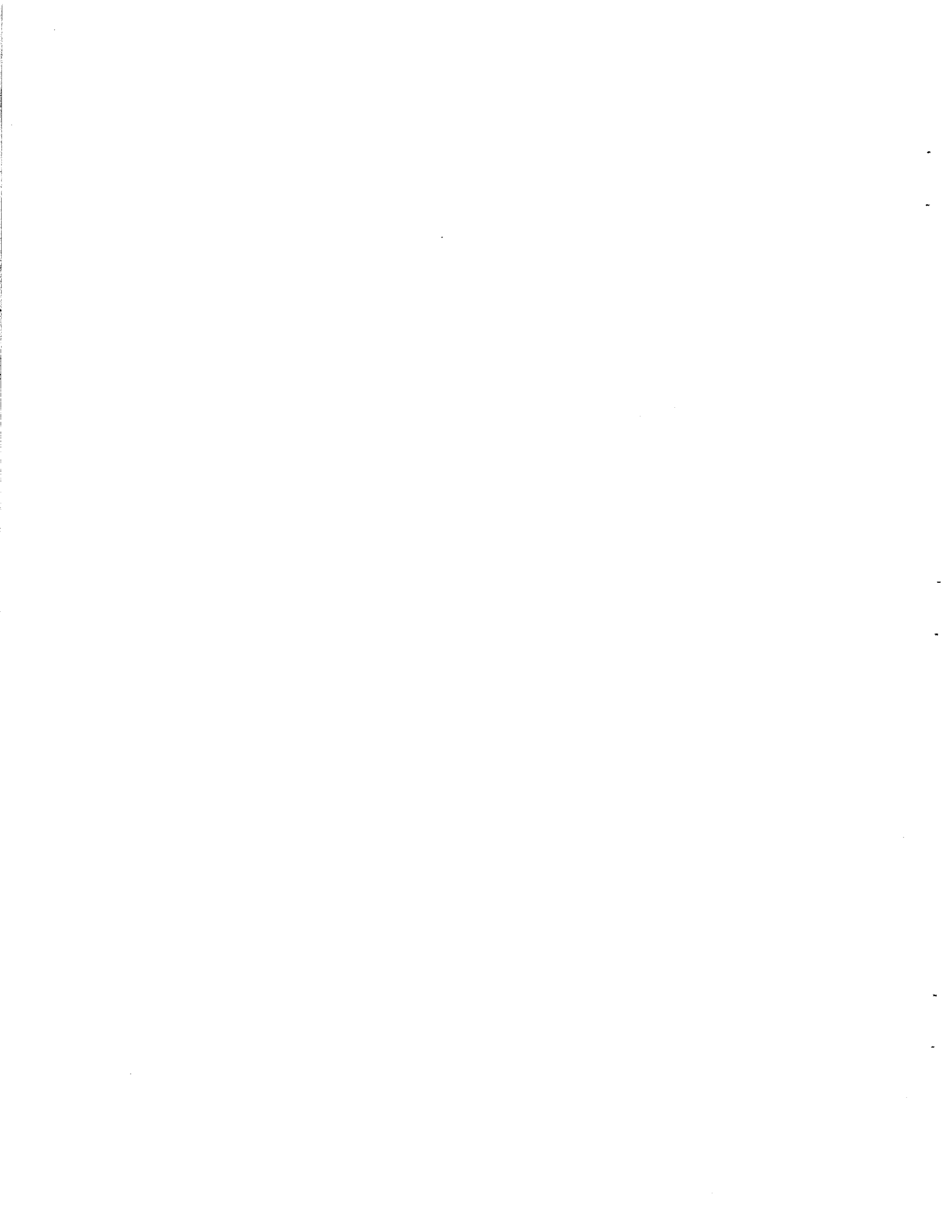


Figure 25. Passenger car wheel set journal showing threaded portion where nut is applied to retain the roller bearing on the journal.

Women are employed in various capacities at the Riga light repair depot. Nevertheless, there are specific restrictions on the types of work that they are permitted to perform. These restrictions are based on such factors as age and place limits on the number of hours that may be worked and the weight of items that may be handled.

The Riga passenger car light repair depot first received the official title of "Depot of Communist Labor" in 1974. This high Soviet honor must be re-earned each year -- and this facility apparently has done so frequently. In conversing with the U.S. delegation, the director of the depot was clearly proud of his shop and the achievement of his workers, stating that 92 percent of the workers fulfilled their productivity goals. In response to a question regarding what management technique is used to maintain such a high standard in this depot, the director explained that there is competition between various work teams and individual workers. Their efforts are evaluated on a monthly basis, with rewards (which include monetary benefits) going to the top three teams and the top three individual workers.

The delegation concluded that the Riga passenger car light repair depot is well managed and well maintained, exhibits excellent house-keeping practices, and performs high-quality work.



SECTION 8: PASSENGER CAR SERVICE AND SERVICING

The Riga passenger train station handles an average of 400 trains per day, including commuter trains, local trains, and long-distance express trains, all of which are part of the Baltic Railroad. On this and other Soviet railroads, commuter trains are trains that run no more than 90 miles, local trains provide service over distances between 90 and 450 miles, and long-distance trains generally are those that travel more than 450 miles.

Commuter service to and from the Riga station is customarily provided by self-propelled electric cars, which are maintained at the locomotive shop. The passenger depot performs light inspections and maintenance in the car-yard. It services an average of 150 cars per day, although this number increases to as much as 300 during the holiday season. The general servicing of passenger cars at the depot includes provision of laundry service, along with associated light cleaning of the car interiors.

As observed by the U.S. delegation on the Baltic Railroad, long-distance passenger trains in the U.S.S.R. provide travelers with a variety of services. On a typical train, for example, there is a beauty shop, as well as a babysitting service in a special children's section. A library contains books that may be borrowed for the duration of the journey. There is also an information bureau to assist passengers in making their travel arrangements.

Long-distance trains usually offer three classes of sleeping car accommodations. These range from high-priced luxurious compartments to modest berths that, although inexpensive, still provide some degree of privacy and comfort. The first-class accommodations, similar to those on U.S. sleeping cars, provide a compartment with a door and two berths on the upper level and two berths on the lower level, with a small table under the window set between the lower level berths.

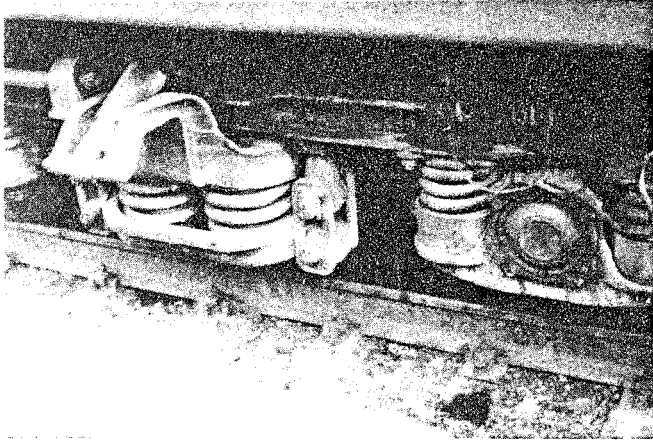
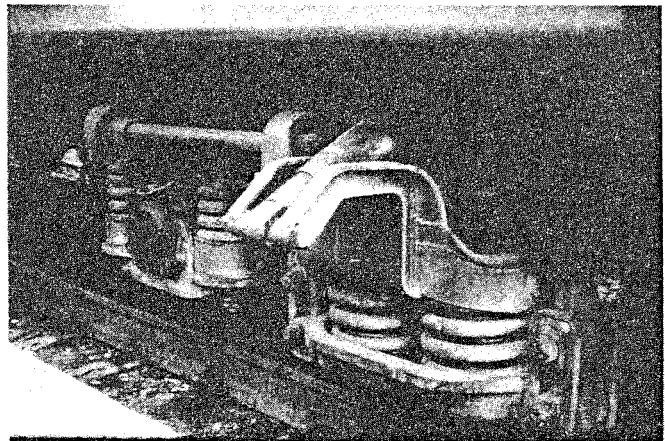


Figure 26. Fabricated passenger car truck used under sleeping cars. Note the wire leading from each roller bearing heat sensor, which is used to transmit the signal from overheated bearing to the attendant's compartment in the car.

Figure 27. Closeup of sleeping car truck.



Each car on a long-distance passenger train on the Baltic Railroad has a toilet compartment with washroom at each end of the car. At one end, there is also a charcoal brazier on which the car attendant heats water to make tea for the passengers.

The attendant's own compartment is the location of an alarm that will automatically sound if there is a sudden rise in the roller bearing temperature. The alarm is linked with a heat detection device attached to the roller bearing. All Soviet passenger cars are equipped with this type of warning system.

While inspecting passenger cars in the Riga depot servicing area, the U.S. delegation noticed that some passenger car trucks have clasp brakes that use high-friction composition shoes on one wheel and cast-iron shoes on the other wheel of the same truck. The delegation was told that, although there is no appreciable difference in wheel life as related to type of brake shoe used on freight cars, composition shoes on passenger cars result in a 20-percent reduction in wheel life. The use of different types of brake shoes on the same truck of a passenger car, it was explained, is a test program to develop information on wheel damage

(as well as wheel life) as related to the use of cast-iron shoes versus high-friction composition shoes. In response to a question concerning the different coefficient of friction between composition and cast-iron shoes, difficulties in technical translation prevented the delegates from obtaining a clearcut answer. Nevertheless, they inferred that, although there is some difference in the coefficient of friction, it is small enough to permit the use of different shoe types on the same truck without causing wheel damage or having a noticeable effect on the test results.

Soviet passenger cars use a standard train line air hose coupling, with a glad hand that appears very similar to that used in the United States. In addition, though, the Soviet cars have a fixture attached to the glad hand and a wire secured to the outside of the air hose. When the glad hand coupling is made, this fixture makes the electrical contact for the electropneumatic brake. Soviet passenger cars use the standard automatic coupler similar to that used on freight cars. In addition, they are equipped with buffers on each side of the car similar to those found on Western European cars. Buffers of this type are not used on Soviet freight equipment.

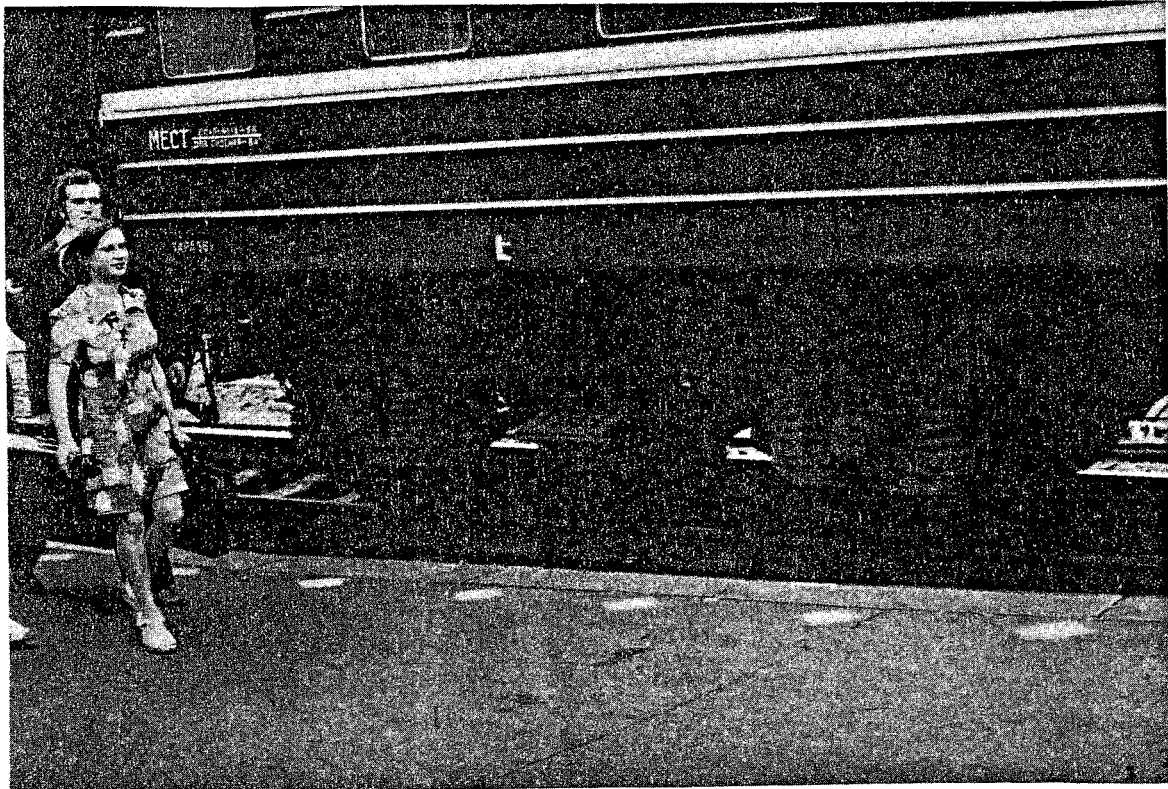


Figure 28. Early type of passenger car truck used on Soviet railroads.

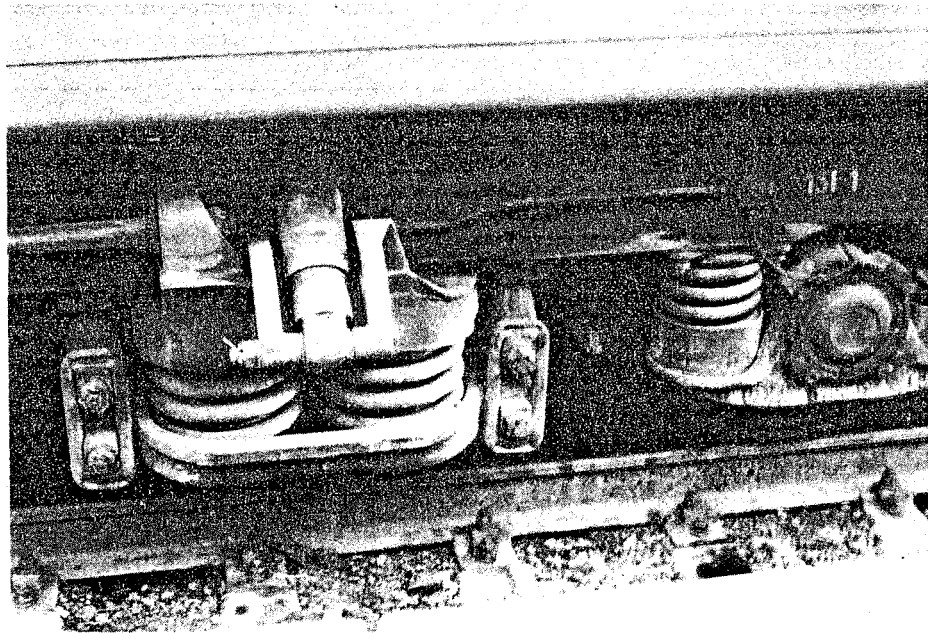


Figure 29. Recent type of passenger car truck used on Soviet railroads.

SECTION 9: REFRIGERATOR CARS

Most of the refrigerator cars used on Soviet railroads are operated as integrated units. Such a unit consists of 5, 7, 10, or 12 refrigerator cars linked with a power car that generates electric power. Nearly all of the remaining cars are operated as single refrigerator cars with individual power units. Although the Soviet railroads still use a few old ice cars, these are expected to be phased out by 1980.

The U.S. delegation was unable to learn exactly how many refrigerator cars are in use on the Soviet railroads. However, based on knowledge of the frequency of refrigerator car inspections and the number of inspection shops, the delegates estimated that there are between 10,000 and 12,000 cars of this type in use in the Soviet Union.

There tends to be a seasonal shortage of refrigerator cars on the Soviet railroads, which customarily use them to transport fruit, meat, milk, and other perishable commodities that must be kept cool during the summer and protected from freezing during the severe winter season (heating units in the cars prevent interior temperatures from dropping too low in winter). During off-peak periods, these cars may be used to transport a specific list of commodities, such as furniture, that will not contaminate the car interiors.

The present Soviet refrigerator car units, conceptualized in 1956, are manufactured in both the U.S.S.R. and East Germany. These units, designed with passenger car trucks for running at speeds up to 75 miles per hour, are normally operated in special trains, particularly during

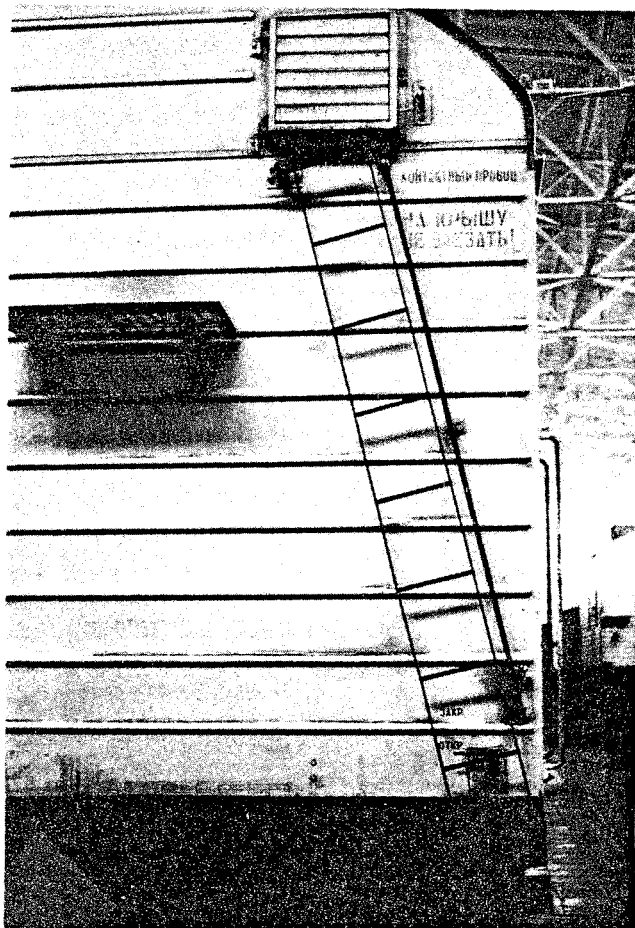


Figure 30. The end ladder on a refrigerator car is secured at an angle when not in use to prevent unauthorized personnel from tampering with the controls.

the peak seasons. However, they also may be operated in standard freight trains.

The five- and seven-car units each use a centrally located single power car that contains two primary diesel motor generator sets. Each diesel develops 126 horsepower at 1,050 revolutions per minute. Together, the generator sets produce the 380-volt, three-phase alternating current that is transmitted to the refrigerator cars. In addition, the power car has a single auxiliary power unit, which is used primarily to provide light and heat for the crew quarters located at the opposite end of the power car.

The larger units of 10 or 12 refrigerator cars have a separate car for crew quarters, as well as a separate power car. These two cars are centrally located within the unit.

Each refrigerator car is 66 feet long and can carry 45 tons in approximately 35 cubic meters of space. The older cars are insulated with styrofoam and the newer cars are insulated with 4-inch-thick polyurethane. A Freon refrigeration system is used. The power car is capable of maintaining a temperature of minus 20 degrees C inside all of the cars in the unit, even when the outside temperature rises as high as 45 degrees C. The temperature in the cars is remotely controlled by the crewmen, so they do not have to leave their quarters. The power car carries enough fuel to operate continuously for up to 300 hours.

Each unit crew consists of three men who have been specially trained to troubleshoot the mechanical, electrical, and refrigeration systems of the unit. The men usually work for 45 days in a row and are then off duty for an equal period of time.

The U.S. delegation was informed that, in the future, Soviet railroads are expected to use refrigerator cars in either of two basic configurations. One is the single, automatic refrigerator car that operates with a self-

contained power unit and no crew support. The other is the five-car unit that includes a combination power and crew support car.

Each refrigerator car unit undergoes routine maintenance at a specific facility on the railroad to which it is assigned. The Ministry of Railway Transport, in Moscow, has a special group that schedules the utilization and maintenance of all Soviet refrigerator car units.

The Predportovaya refrigerator car shop, located just outside the city limits of Leningrad, was constructed in 1973. As the U.S. delegation learned during its visit to this car shop, the facility is one of ten refrigerator car maintenance facilities on the Soviet railroad system.

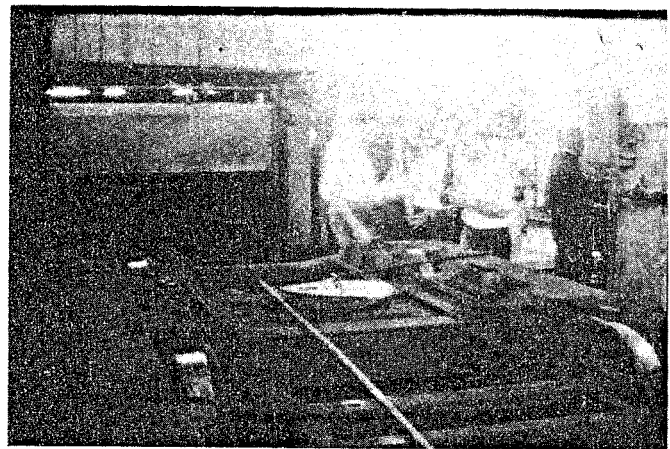
This maintenance depot, which employs a total of 400 people (including management and support personnel), normally services 100 cars per month and specializes in maintaining five-car units built in East Germany.

The cars are scheduled for maintenance once every 18 months. The standard maintenance procedure used on each car is to remove and disassemble the trucks; repair truck components as needed; change or turn the wheels; remove and inspect the couplers, yokes, and draft gear; paint the car; and service the refrigeration unit, diesel engine generator sets, and other electrical equipment.

The primary assembly shop, which operates on a single shift, consists of two tracks and a truck disassembly facility where the trucks are cleaned before disassembly. There are a total of ten support facilities, including one for waste water treatment; these are operated on either a two- or three-shift basis.

Following its tour of the Predportovaya refrigerator car shop, the U.S. delegation concluded that this is a well-managed facility, where the quality of work is excellent and well organized and the housekeeping is very good.

Figure 31. Refrigerator car truck ready to enter the truck-cleaning station prior to disassembly and inspection.



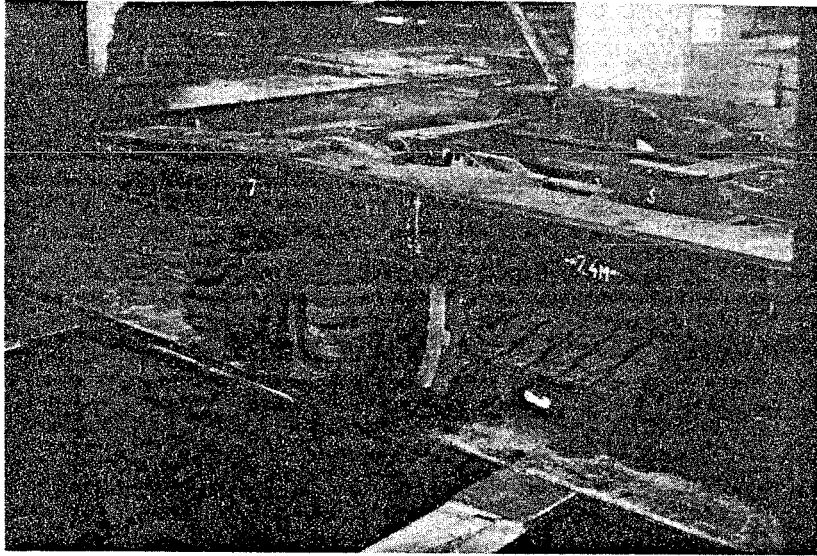


Figure 32. Reassembled truck ready to go back under refrigerator car after inspection and repair.



Figure 33. Refrigerator car light repair shop.

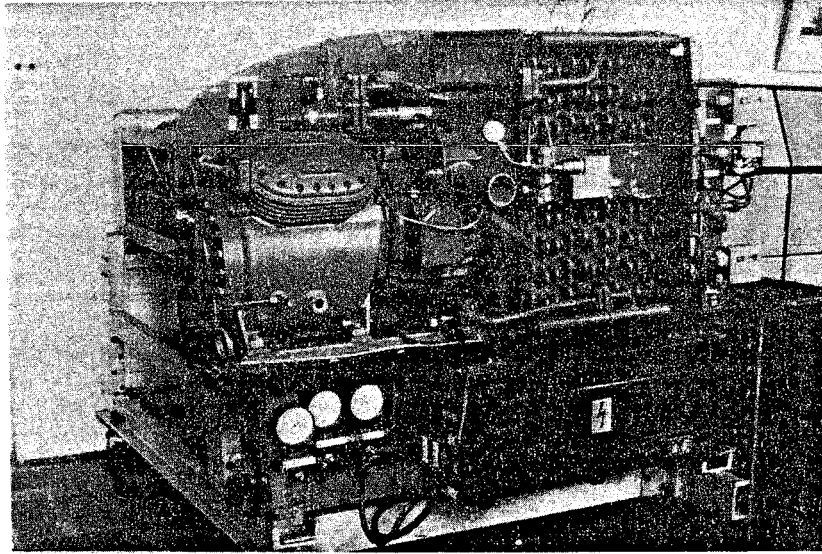


Figure 34. A unitized refrigerator car motor compression unit ready for insertion in the end compartment of a refrigerator car.

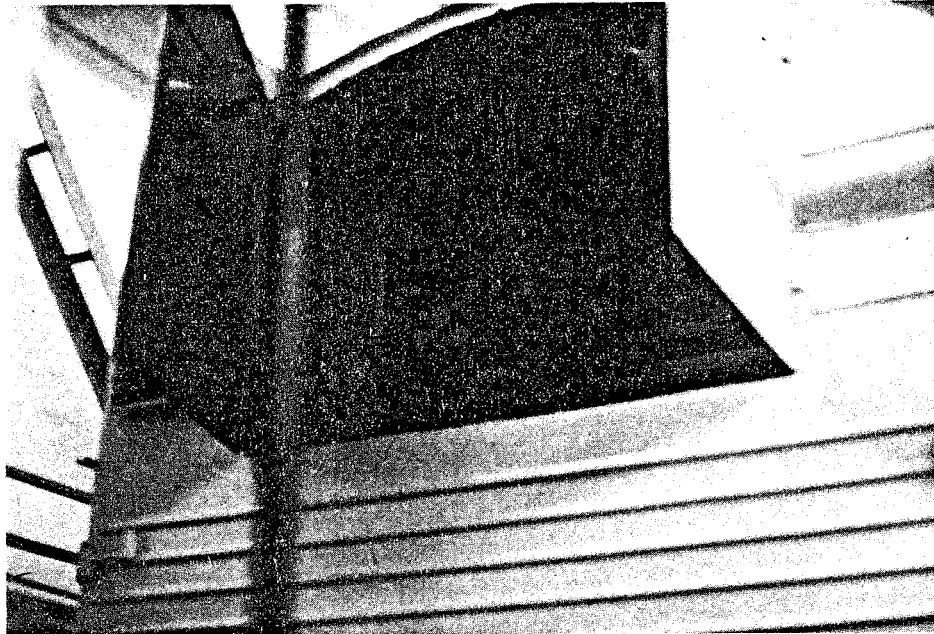


Figure 35. The end compartment of a refrigerator car showing the motor compression unit in place.

SECTION 10: SHCHERBINKA TEST LOOP AND LABORATORIES

The Shcherbinka test loop, located about 18 miles outside of Moscow, is the principal testing facility for the Soviet railroad system. All new designs of railroad cars and locomotives have to be tested at Shcherbinka before production is approved and initiated. The facility is operated by the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport.

The original Shcherbinka test loop, approximately 4 miles in length, was constructed early in the 1930's and was electrified -- with overhead catenary -- later in the same decade. The track was modernized in 1967, when heavier rail was installed and superelevation was increased to about 3½ inches, thereby permitting train speeds of up to 85 miles per hour. In 1973, a straight section of track -- approximately 2,600 feet long -- was added to the test track.

The Shcherbinka facility now has a total of three loops, two additional loop tracks having been constructed inside the original outer loop. One of the inner loops is constructed with wood ties and the other with concrete ties. Normally, rail and track testing is done on the two inner loops, with vehicle and equipment testing being carried out on the outer loop. Test trains operating on a two-shift basis cover 600 miles a day on the Shcherbinka test tracks.

In addition to the test loops, the Shcherbinka facility, which employs a total of 350 people, includes specialized research laboratories and testing facilities. Used to supplement the running tests performed on the test tracks, these units specialize in such activities as research on electric rolling stock, electric trains, catenary equipment, passenger car electrical equipment, insulation of diesel locomotive traction motors, diesel equipment, wheelsets, roller bearings, wheel-rail dynamics, and braking systems and friction units; spectrographic analysis of lubricating oil; rail testing; car strength testing; and fatigue testing of truck frames and frame components.

During its tour of the Shcherbinka facility, the U.S. delegation was shown a 500-ton compression/tension test device for car and locomotive underframes. Capable of handling vehicles up to 90 feet long, this device is used to apply vertical loads pneumatically to full-scale cars under test and can develop a force of up to 300 metric tons at a rate of about 12 tons per minute.

The delegation also visited the impact track, where a ramp permits a freight car to attain a maximum speed of 15 miles per hour prior to impact. A car puller is designed for either isolated impacts or an automatic cycle of



Figure 36. A view of the tracks of the three test loops at Shcherbinka, as seen from the station platform.

repeated impacts, which are carried out from any hump height as determined by the desired impact speed. The test car can be equipped with a unique crossbeam attached to the coupler. The ends of this crossbeam contact concrete abutments before the opposite end of the car hits the stops, thereby enabling the coupler to be impacted in tension or compression.

While touring Shcherbinka, the delegation saw several types of new equipment that had been on display earlier at the July 1977 international railroad exhibition. These items included the newly designed Soviet eight-axle tank car, which uses four conventional two-axle freight car trucks equipped with roller bearings and a span bolster arrangement. Designed for a maximum curvature of 250-foot radius, this car has a capacity of 125 metric tons or 30,000 gallons.

The new equipment also included a three-axle locomotive truck capable of operating at speeds of up to 125 miles per hour. The axle-mounted traction motors are suspended in such a way that the weight of each motor was not added to the unsprung weight of the wheelset. The delegation also inspected recently designed locomotives intended for heavy grade mining operations; these units have axle ratings of 30 metric tons and utilize slugs between the power units. Also on display were a new 20-cylinder, V-type diesel engine generator assembly, which is used in modern road diesel locomotives, and various types of new track maintenance equipment.

At the wheel-brake shoe dynamometer laboratory, the delegation observed a simulated high-speed stop. New brake shoe material that shows good results after initial laboratory testing is further tested on a special ten-car train operated on the outer loop of the test track. The delegation was told that, regardless of the laboratory test results, it is most essential to test the brake shoes on the test train because of the differences between laboratory dynamometer conditions and actual wheel-rail reactions.

At Shcherbinka, the delegation also witnessed fatigue testing of a three-axle, fabricated locomotive truck frame. The test rig on which this is performed uses 16 hydraulic jacks to apply vertical and horizontal forces of up to 25 metric tons to the truck frame. Nine hydraulic pulsators permit fatigue testing at frequencies of 5, 7½, 10, and 16 hertz.

In the same building there is a truck component fatigue test machine that is used to test truck sides, bolsters, and other large truck components. The machine can apply a maximum vertical load of 50 metric tons and a maximum horizontal load of 25 metric tons. Both bending and torsional deformation can be produced, and hydraulic pulsators provide the same range of frequencies as in the larger machine; however, only six hydraulic jacks are used in this unit. There was general agreement among the delegation members that this appeared to be a very efficiently designed rig for fatigue testing large components.

The delegation also visited the building in which a drop hammer is used for notch testing rail sections. Rams weighing either 1, 2, or 3 metric tons can be dropped from a maximum height of 37 feet. Refrigeration units are available capable of lowering the temperature of 3-foot sections of rail to minus 1,100 degrees C. A 500-metric-ton press is used to test static strength. The delegation observed the testing of a rail section that had been reduced to a low temperature. This section was subjected to the impact of the drop hammer and the result was a typical brittle fracture producing five or six pieces.

During the discussions at the conclusion of the Shcherbinka tour, the delegation was told that the Soviet authorities are currently testing axle loadings of 25 metric tons on freight cars (equivalent to the U.S. railroads' 70-ton capacity, four-axle freight car loading). While the test is not yet complete, preliminary findings indicate that such loadings produce no more adverse effects on track than do the new standard 22-metric-ton axle loads.

In response to a question concerning relative benefits of wood and concrete ties, the delegation was told that wood ties are superior when considering the effect upon a rail vehicle and its wheels, trucks, and other components, but that concrete ties have some advantages from a track maintenance standpoint; furthermore, with the shortage of suitable wood for ties, there has been an increased use in concrete ties on Soviet railroads.

After leaving Shcherbinka, the delegation traveled to the headquarters of the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport, in Moscow, where the delegates witnessed the operation of a 100-car air brake test rack before conferring with the institute director and his staff.

The meeting included discussions about the new elastomer roller bearing adapter insert that is being tested on the Soviet railroads. The elastomer insert, with a thickness ranging from 1 inch to about ¼ inch, fits over the top half of the cylindrical bearing race, and the adapter fits on top of this insert. The delegation learned that the use of this insert substantially reduces roller bearing failures attributable to fatigue. The delegation was shown an insert that had been in service for 150,000 miles, and there appeared to be no evidence of wear or deterioration. Soviet tests to date (1977) indicate that the insert will extend the life of the cylindrical roller bearing 2½ to 3 times. Laboratory tests have shown that the insert can be adapted to the AAR standard tapered roller bearing and adapter used in the United States. Furthermore, it has the capability of withstanding the 100-ton capacity freight car axle loading used on U.S. railroads. The U.S. delegates and Soviet officials discussed the possibility of further joint testing of this insert by both countries.

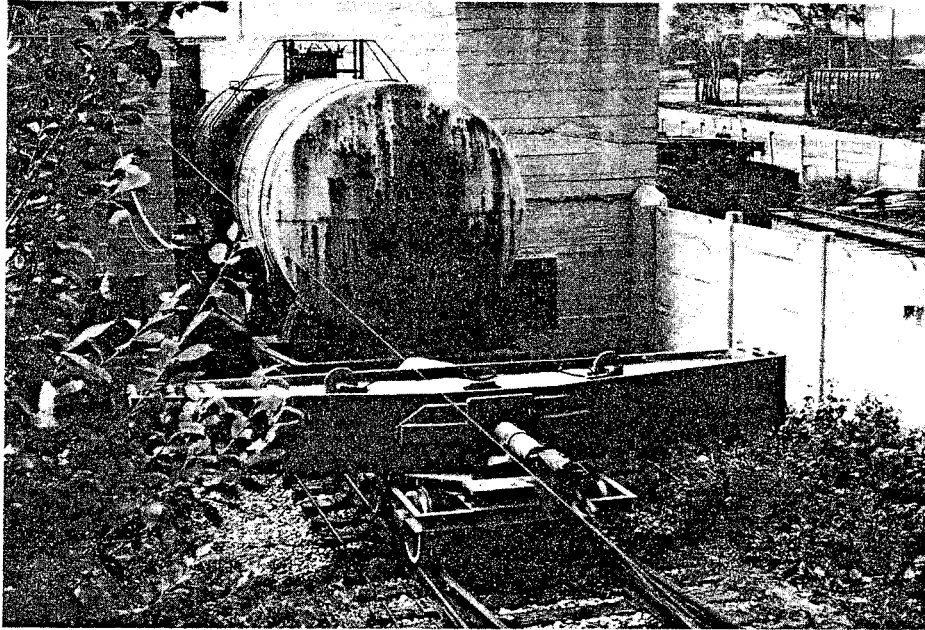


Figure 37. The ramp at the impact track, showing a test car with its crossbeam applied so as to impact the coupler and draft gear in the tension mode.

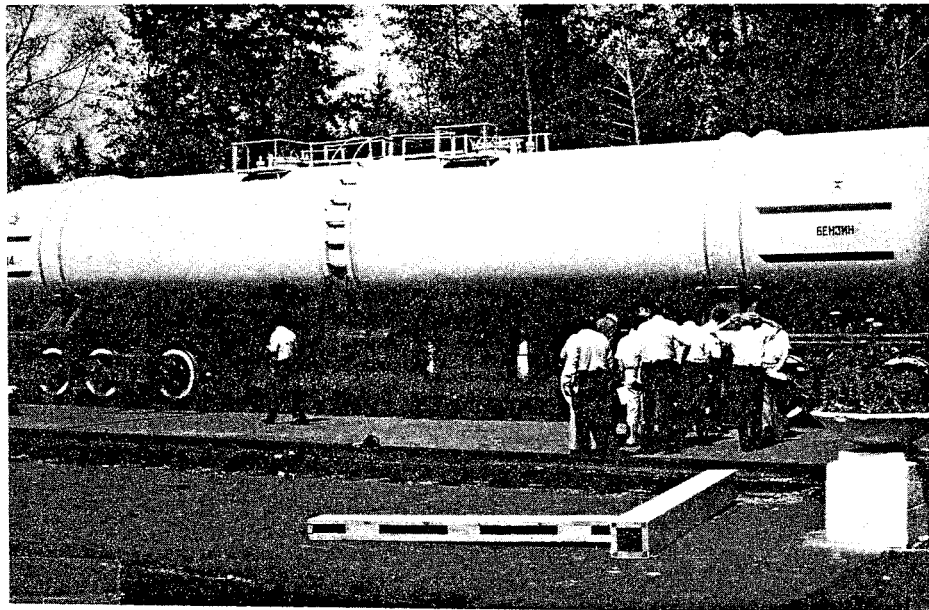


Figure 38. The new Soviet eight-axle tank car.

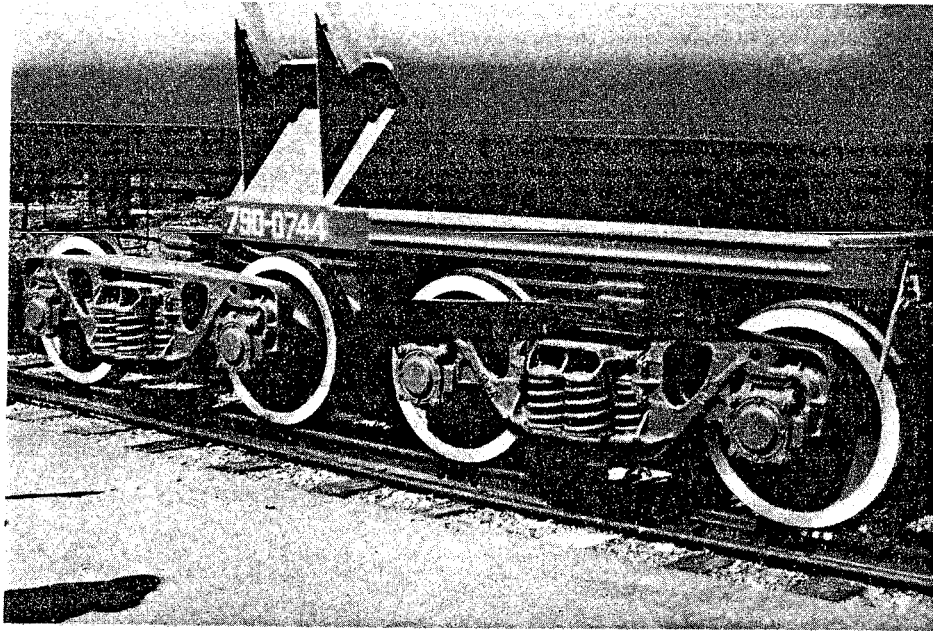


Figure 39. Closeup of the tracks of the new eight-axle tank car.

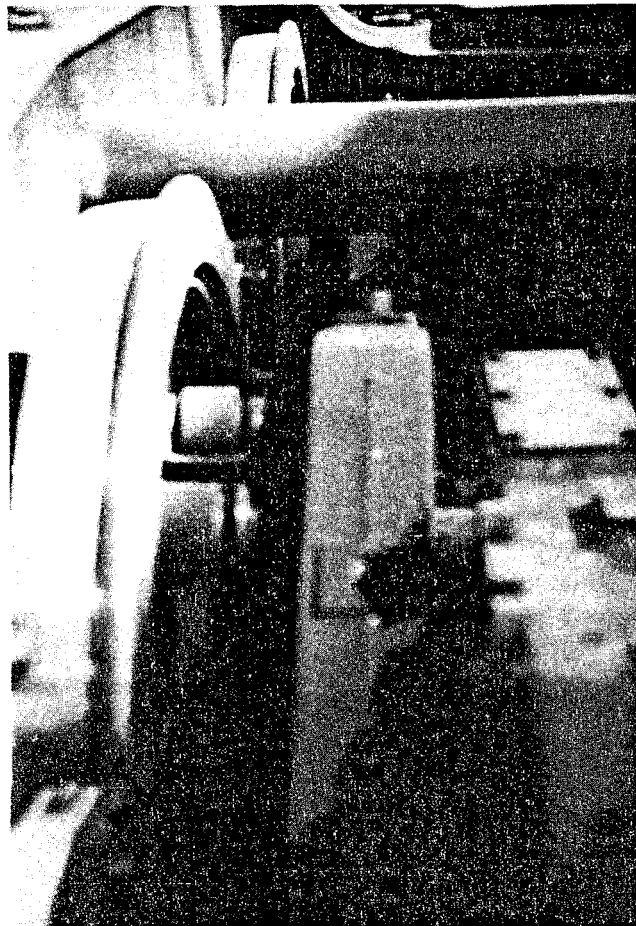


Figure 40. High-speed locomotive traction motor suspension system.

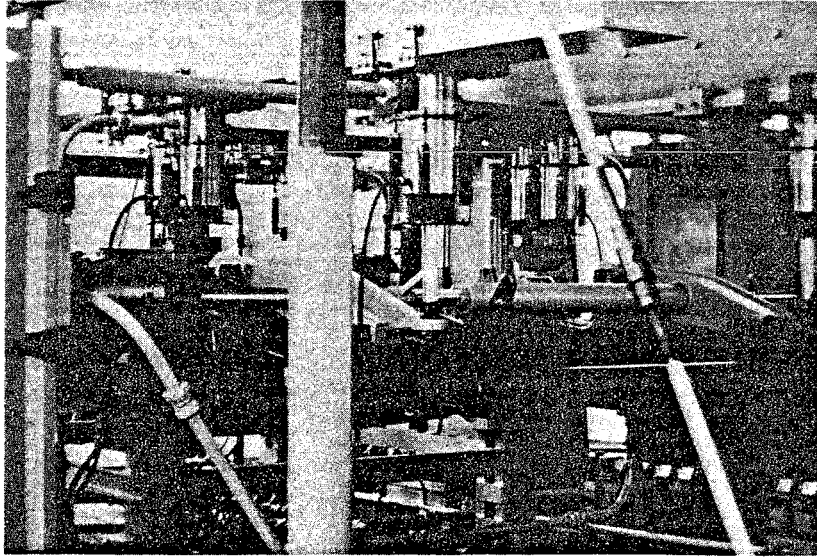


Figure 41. Fatigue testing of a locomotive truck at the Shcherbinka facility.

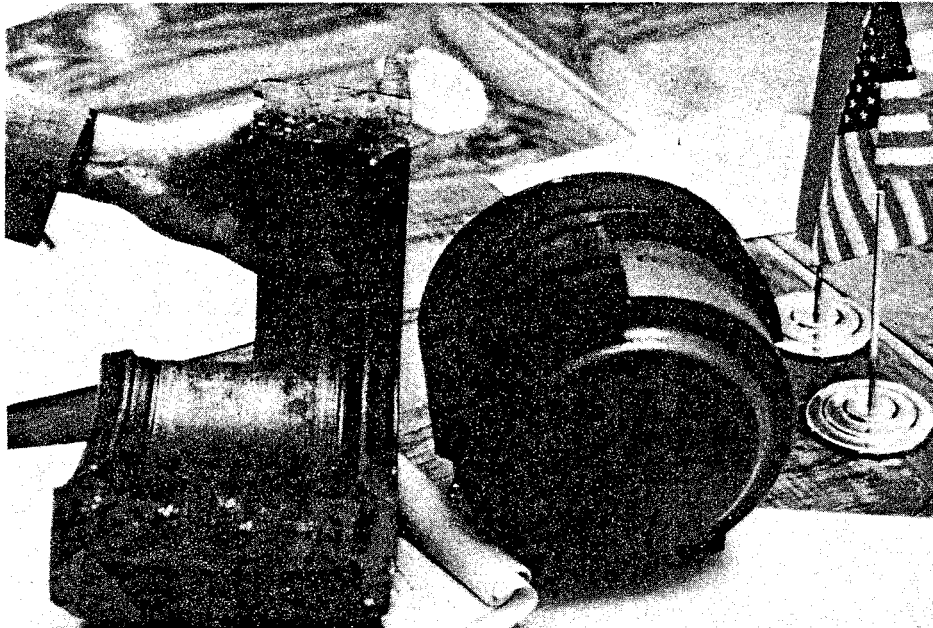


Figure 42. Roller bearing (right) and bearing adapter (left) displayed in cutaway form to show the elastomer insert that fits between the bearing and adapter.

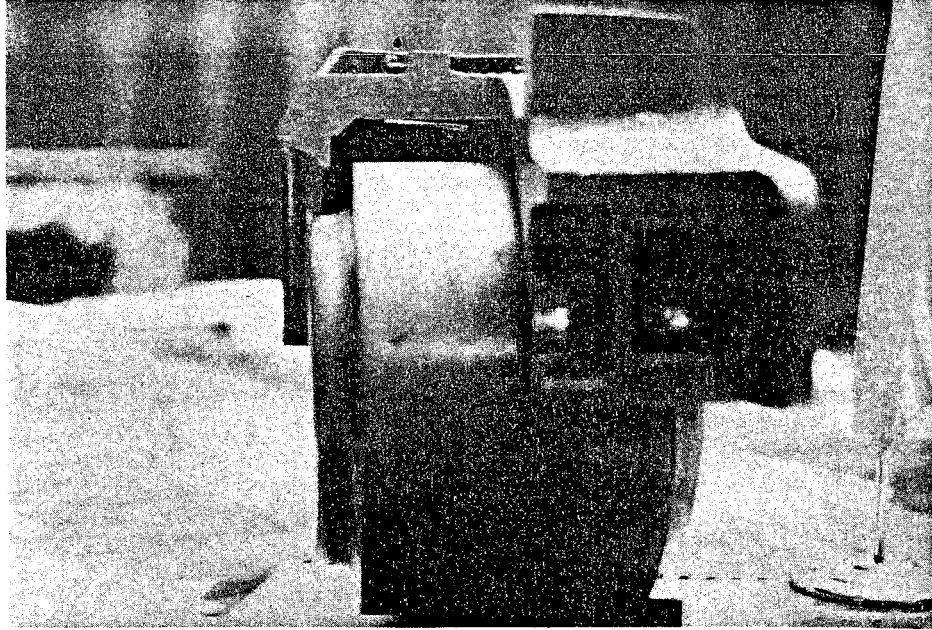


Figure 43. Closeup of the cutaway roller bearing and bearing adapter in place, showing the elastomer insert in cross section.



Figure 44. A complete elastomer insert (foreground), and the roller bearing, bearing adapter, and elastomer insert displayed in cutaway form.

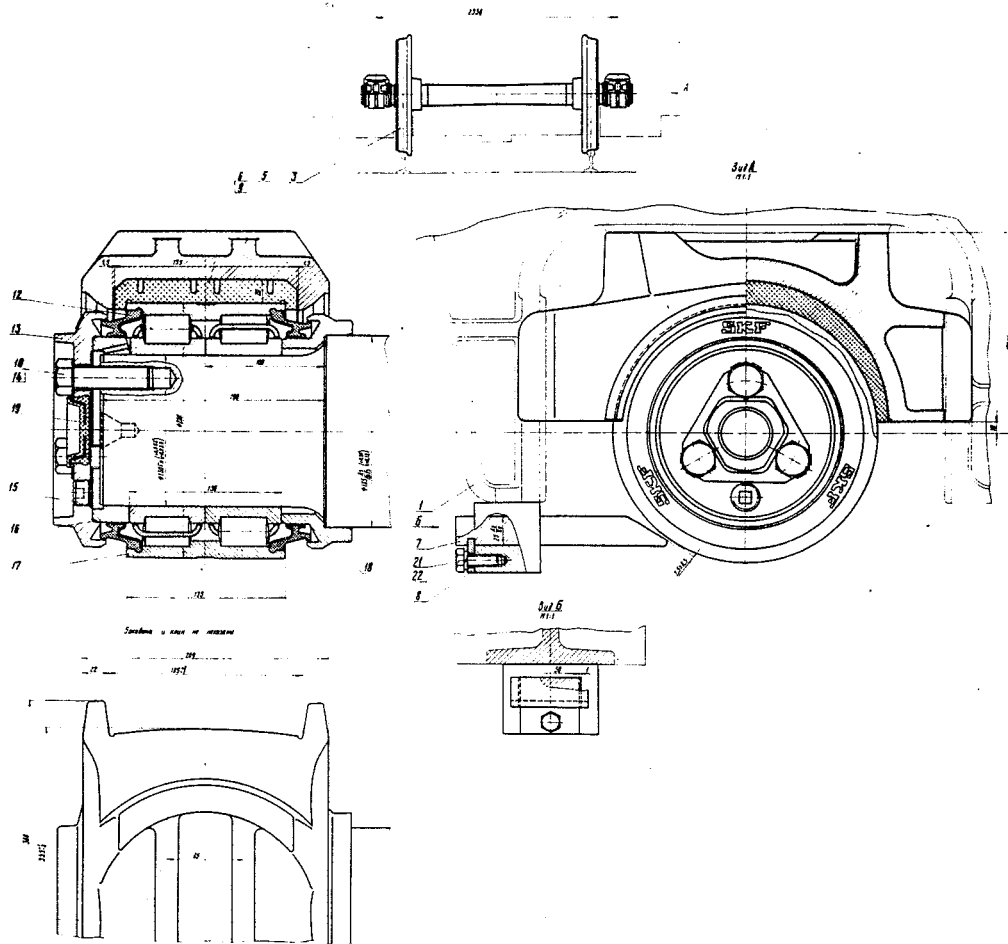


Figure 45. Details of the elastomer insert used between the roller bearing and the bearing adaptor.

SECTION 11: RAILWAY ENGINEERING INSTITUTE (LENINGRAD)

The U.S.S.R. has a total of 15 transportation institutes for railway engineering. Of these, the one in Moscow ranks as the largest and the one in Leningrad as the second largest.

The institute in Leningrad was founded in 1809 as the first technical institute in Russia. Throughout the nineteenth century, it was the only engineering institute in the entire country. After the introduction of railroads in Russia during the middle of the century, the institute began training railroad engineers, primarily in the civil engineering field.

At present (1977), the institute has 1,500 professors and teachers who are also active in research work and 13,000 enrolled students, of whom about 5,000 live in hostels in or near the institute complex. The institute furnishes full-time student courses, evening student courses, and correspondence courses. There are almost 50 departments at the institute that provide academic training in all disciplines of railway engineering, as well as programs for engineers who work for companies that produce components used on Soviet railroads.

The institute's entrance requirements are rather strict, at least in view of the visiting U.S. delegation. Only two out of five students who apply are accepted for admittance. There are, however, provisions for the preliminary training for students who do not qualify; after a year of study, they are permitted to take the entrance examination and, if successful, are invited to enter the institute.

A typical full-time student spends 5 years at the institute in studying for his bachelor of science degree, including a year spent in full-time work as an engineer. Thereafter, if qualified, he may spend 3 additional years as a

full-time student to obtain a degree as a candidate for advanced studies. Then, after 2 additional years of experience working as an engineer, he is qualified to study for a doctoral degree in engineering.

After graduation, the student who accepts a position in the railroad engineering field or an engineering field in associated industries is required to return to the institute once every 5 years for a 3-month refresher course.

The Leningrad institute maintains extensive laboratories for the use of its faculty and students. These laboratories include some very large model railroad layouts, which are coupled to centralized traffic control panels and used to train students in all phases of railroad operation.

Within the complex there is also a railroad museum. Established in 1902, it now occupies 10 halls and houses displays that include models of all major types of motive power and railroad vehicles, as well as major bridges designed by graduates of the institute. For the visiting U.S. delegation, this museum was a graphic illustration of the development of railroad transportation in the Soviet Union.

The U.S. delegation's visit to the Railway Engineering Institute reinforced the delegates' perception that railroad engineering is considered to constitute the backbone of the Soviet railroad system. The present (1977) Soviet minister of railways has spent his entire career in the railroad industry. Having earned a doctoral degree in engineering, he took on detailed engineering assignments during the early phases of his career and subsequently made his way through the operating department to the highest levels of railroad management.

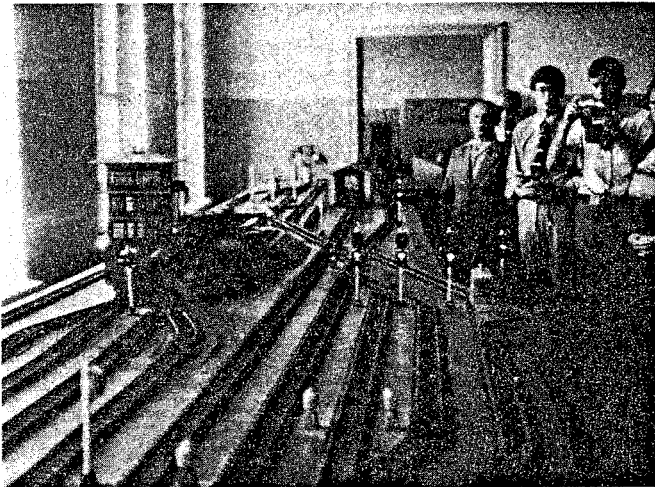


Figure 46. Model railroad showing the crest of the hump next to the hump tower on the left, with typical yard tracks on the right.

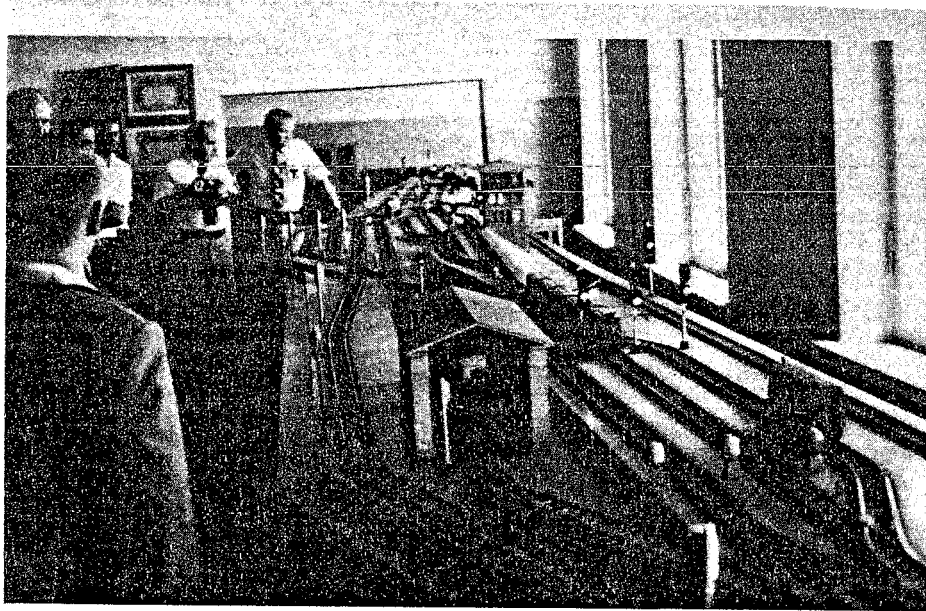


Figure 47. Overview of a model railroad layout at the Railway Engineering Institute in Leningrad.

APPENDIX A

MEMBERS OF THE U.S. DELEGATION

R. E. Parsons*
Associate Administrator for Research and
Development
Federal Railroad Administration
U.S. Department of Transportation
400 Seventh Street, SW.
Washington, D.C. 20590

L. A. Peterson
Director, Office of Rail Safety Research
Federal Railroad Administration
U.S. Department of Transportation
400 Seventh Street, SW.
Washington, D.C. 20590

F. A. Danahy
Executive Director-Mechanical Division
Association of American Railroads
1920 L Street, NW.
Washington, D.C. 20036

W. J. Ruprecht
Director of Engineering
Shippers Car Line Division
620 North Second Street
Saint Charles, Missouri 63301

A. E. Hinson
Director, Research and Test Department
Southern Railway Company
P.O. Box 233
Alexandria, Virginia 22313

M. M. Jelisavcic
Interpreter
Unified Industries Incorporated
5400 Cherokee Avenue
Alexandria, Virginia 22312

T. D. Mason
Assistant to the Vice President, Operations
The Atchison, Topeka & Santa Fe Railway Company
80 East Jackson Boulevard
Chicago, Illinois 60604

*Head of delegation.

APPENDIX B

RECORD OF PROCEEDINGS OF THE SIXTH MEETING OF
THE JOINT AMERICAN-SOVIET RAILROAD WORKING GROUP

The sixth meeting of the Joint American-Soviet Working Group on Railroad Transportation took place in Moscow from August 4 through August 15, 1977.

Participants in the meeting were (from the Ministry of Railway Transport (MRT U.S.S.R)):

N. V. Kolodyaznyi, Co-chairman of the Joint American-Soviet Railway Working Group

V. N. Paschenko

L. V. Malashko

N. A. Fufrianskey

A. I. Rechkalov

V. G. Inozemtsev

V. N. Bobkov

B. E. Lukov

V. G. Shatunov

Participants in the meeting from the U.S. Department of Transportation, Federal Railroad Administration (USA, DOT, FRA) were:

R. E. Parsons, Co-chairman of the Joint American-Soviet Railway Working Group

F. A. Danahy

A. E. Hinson

T. D. Mason

L. A. Peterson

W. J. Ruprecht

M. Jelisavcic

The following agenda was adopted at the meeting:

1. Review of the results of cooperation for the period between the fifth and sixth meetings of the working group.

2. Review of the proposals by the two sides and an agreement on topics of scientific-technical cooperation for 1978.

3. Review the progress in fulfilling the plan of joint research on the topic: "The Organization of High-Speed Movement of Passenger Trains (up to 200 km/h) on Existing Lines."

4. Agreement on the place and time for convening the seventh meeting of the working group.

Item 1. The two sides reviewed the progress in fulfilling the measures on the Program of Cooperation, taken at the fifth meeting of the Working Group (May 28, 1976, Washington) and noted the following:

-- From June 15 through June 25, 1976, a USA, DOT, FRA delegation was familiarized on Soviet railroads with repair, maintenance and

control of the condition of rails, with questions on increasing rail service life as well as with the experience of the repair and maintenance of track, methods of testing track designs on the experimental loop of the TsNII at the Shcherbinka Station.

-- From July 5 through 17, 1977, a delegation of the MRT U.S.S.R. was familiarized with the design, production and operational experience, repair and maintenance of diesel locomotives at the facilities of American Locomotive manufacturers and the U.S. railroad companies.

-- From August 4 through 15, 1977, a USA, DOT, FRA delegation was familiarized with the design, production, operational experience, repair and maintenance of cars at facilities of the industry and on Soviet railroads.

-- In accordance with point 2.1 of the protocol of the fifth meeting of the working group, the Soviet side informed the USA, DOT, FRA on results of tests on an American draft gear of freight car automatic coupler carried out in the TsNII MRT U.S.S.R. and turned over a short written report on results of the tests. The USA, DOT, FRA informed the Soviet side on tests carried out in the Technical Center of the Association of American Railroads on 12 Soviet concrete ties and turned over a short written report on the results of these tests.

-- The mutual exchange of technical information on the agreed topics is continuing and both sides confirmed their agreement to complete before the end of 1977 the exchange of technical information as indicated in point 2.2 of the protocol of the fifth meeting of the working group.

The two sides confirmed their mutual interest and usefulness for the further development of scientific-technical cooperation and consider it expedient to continue the exchange of scientific-technical information and to exchange visits by specialists of both sides to study technical subjects of interest, as well as the exchange of samples of railway equipment for test.

Item 2. The two sides accepted the following recommendations on a plan of cooperation for 1978, for their presentation and affirmation by the Joint American-Soviet Committee on Transportation:

2.1 The two sides agreed to continue in 1978 the exchange of technical information on subjects of the operation, improvement, and development of railroad transportation. The USA, DOT, FRA will forward to the MRT U.S.S.R. technical information on the questions:

-- The system of organization (philosophy), the technology and means of mechanizing the repair of switches and frogs at fixed installations and

in track.

-- The system of organization (philosophy) of transporting frost susceptible cargo and the means of the mechanization of unloading frost susceptible loads.

MRT U.S.S.R. will forward the USA, DOT, FRA technical information on the following subjects:

-- The means and methods employed to provide for trouble free and dependable operations of locomotives and passenger and freight cars in cold weather.

-- System of intermodal container traffic (rail/truck) to include design of intermodal containers, container handling equipment used at container sites and terminals, as well as the technical characteristics of such; technical information on future development of intermodal container traffic: rail/truck and rail/ship.

2.2 The sides have agreed to carry out joint work on improving methods and technical means for accelerated life cycle tests of rolling stock and its influence on track. The two sides adopted a working plan on carrying out joint tests of rolling stock which is recorded in appendix 1.

In 1978 the MRT U.S.S.R. will turn over to the USA, DOT, FRA the methodology and information on the technical means used to carry out accelerated life cycle tests of rolling stock at the experimental loop of TsNII at Shcherbinka. USA, DOT, FRA will turn over to the MRT U.S.S.R. the methodology and information on the technical means used for accelerated testing of rolling stock on the experimental loop at Pueblo. The sides will further carry out on the experimental loop of C.S.R.I. at Shcherbinka and on the experimental loop at Pueblo comparative tests of comparable types of rolling stock by Soviet and American methods.

2.3 The MRT U.S.S.R. will receive a USA, DOT, FRA delegation in 1978, in the second quarter, of up to 8 persons for a period of 12 days to study the design, development, manufacturing techniques, manufacturing plant facilities, maintenance, and operation of electric and diesel locomotives.

The USA, DOT, FRA will receive, in the third quarter 1978, a MRT U.S.S.R. delegation composed of 8 persons for a period of 12 days to study automated systems for train traffic control and the work of marshalling yards using computers.

The sides will exchange, before the end of the first quarter 1978, lists of questions for study during the indicated trips.

2.4 On the proposal of the MRT U.S.S.R., the sides agreed to exchange opinions on carrying out comparative joint tests of roller bearing, freight car box assemblies with the objective to develop recommendations for increasing their reliability and service life based on the

results of these tests. MRT U.S.S.R., by the end of 1977, will send to USA, DOT, FRA proposals on this subject. The FRA will advise the MRT U.S.S.R. on their opinion on such joint tests by March 1, 1978.

2.5 The sides noted the effectiveness of the technical cooperation involving exchange of samples of railway hardware, such as the exchange of the American automatic coupler draft gear and the Soviet concrete ties, that has been accomplished, and it is considered useful to continue such exchanges to include flaw detection devices. The sides agreed by November 1, 1977, to advise each other on specific samples of U.S.S.R. and USA railway hardware which they would like to exchange for testing.

Item 3. The sides have informed each other on the progress of fulfilling the plan of joint research on the topic: "The Running of High-Speed Passenger Trains (up to 200 km/h) on Existing Lines," and confirmed their willingness to fulfill joint research on the indicated topic by the indicated volume and period in the working plan agreed on at the fourth meeting of the working group (September 3, 1975, Moscow).

Item 4. The sides agreed to convene the seventh meeting of the American-Soviet Working Group on Railroad Transportation in 1978, in Washington.

This record of proceedings was signed in Moscow on August 15, 1977, in two copies, in the English and Russian languages, both texts being equally authentic.

/Signed/

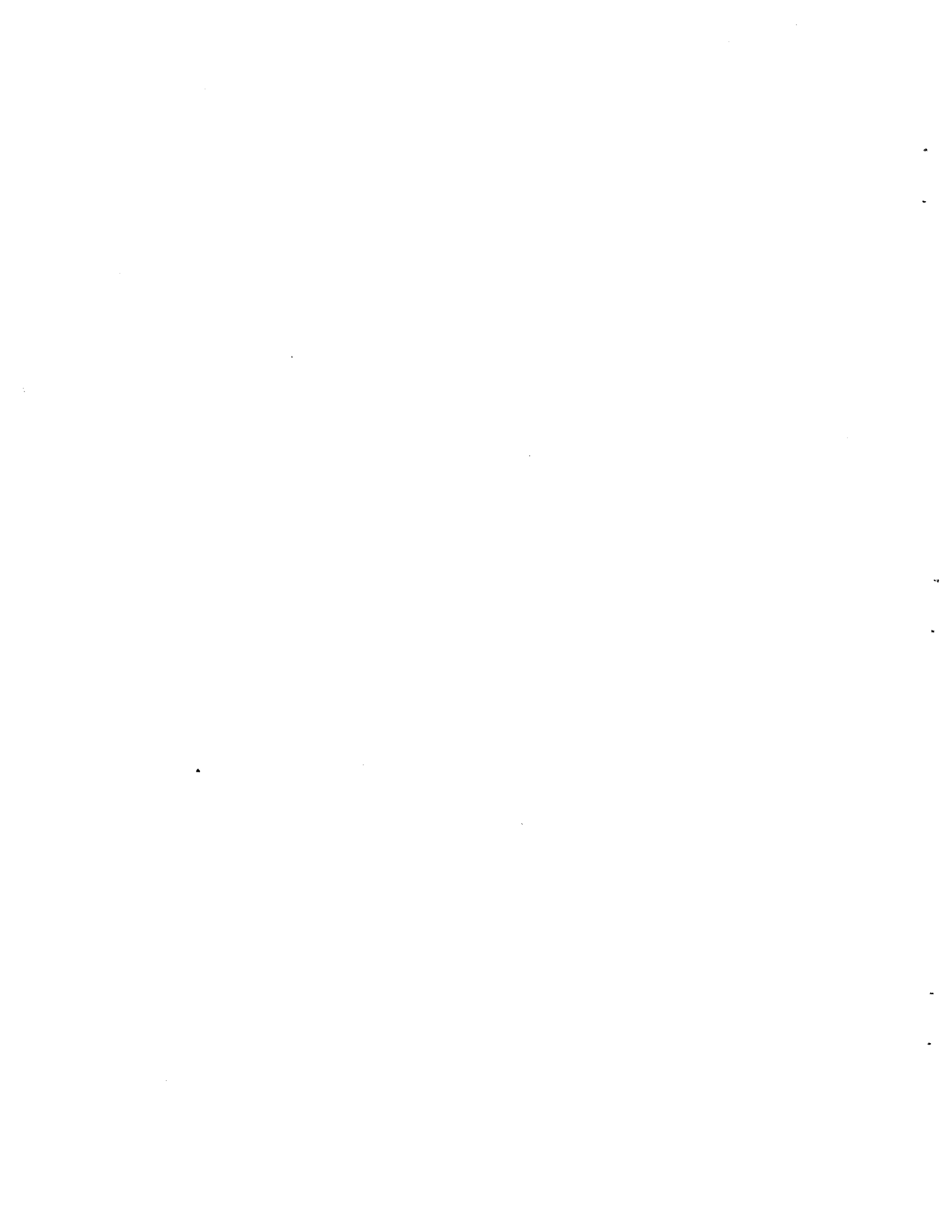
R. PARSONS
Co-chairman of the American Side
of the Joint American-Soviet
Working Group on Railroad
Transportation

/Signed/

N. KOLODYAZNYI
Co-chairman of the Soviet Side of
the Joint American-Soviet Working
Group on Railroad Transportation

APPENDIX 1
 WORKING PLAN
 FOR JOINT USA/U.S.S.R. RAILWAYS ACTIVITIES ON
 THE TOPIC OF: ACCELERATED TESTS OF ROLLING STOCK

Item No.	Activities	Completion Time	Results and Recommendations	Methods of Cooperation (Exchange of Information, Familiarization, Trips, Exchange of Recommendations, Meetings to Discuss Results)
1	Verify/improve criteria for the selection of rolling stock designs aimed at increasing the carrying capacity and economic efficiency of railway transport. Develop methods for increasing reliability of the locomotives and the rolling stock.	1978	Reports containing recommendations.	Exchange reports.
2	Selection of test track suitable to carry out dynamic, life endurance tests of locomotives, and the rolling stock and their interaction with tracks. Development of a test program.	1978	1. Recommendations on selections of a suitable track. 2. Test program reports on test results.	Meeting of experts to discuss recommendations on items 1 and 2 at the next working group meeting.
3	Carry out tests of locomotives and cars.	By 1980		Exchange reports (third quarter 1980).
	Discussion of the results of working plan.	1980	Reports with recommendations for improving designs of locomotives, cars, and track, as well as the methods of testing them.	Meeting of experts of both sides to work out a joint report on test results. Time and place to be set at the next working group meeting.



APPENDIX C

U.S. DELEGATION'S ITINERARY

The U.S. delegation undertook a 13-day tour of the U.S.S.R. to study Soviet rolling stock technology and participate in the sixth meeting of the Joint American-Soviet Railroad Working Group. The delegation's day-by-day itinerary and activities are summarized below.

Wednesday, August 3

Arrived in Moscow in the evening.

Thursday, August 4

In the morning, traveled to the Shcherbinka test facility, 18 miles outside of Moscow, to observe testing activities, tour some of the laboratories and shops, confer with Shcherbinka officials, and attend opening session of sixth meeting of the Joint American-Soviet Working Group.

On the return trip to Moscow, visited the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport (Russian acronym: TsNII). While at the institute, conferred with director and his staff and observed an air brake test rack in operation. Later, was taken on tour of one of Moscow's five passenger stations.

In the evening, left Moscow on an overnight trip by train to Kiev, the capital city of the Ukrainian Soviet Socialist Republic.

Friday, August 5

Arrived in Kiev in the morning. Then toured the Darnitsa freight car plant, which specializes in the repair of covered box cars and open-top gondola cars, and held general discussions with the plant director and other personnel. Later, was taken to visit some of Kiev's historical places of interest.

Saturday and Sunday, August 6 and 7

Went sightseeing. Rode on the local subway system, and was taken on an excursion boat ride. Also visited a railroad-owned recreational and rehabilitation camp outside Kiev.

In the evening of August 7, left by train for an overnight journey to Riga, the capital city of the Soviet Socialist Republic of Latvia.

Monday, August 8

Toured the Riga passenger car light repair depot to observe passenger car maintenance practices and to confer with the director of the depot.

Tuesday, August 9

Visited the Riga passenger car manufacturing plant, which produces both diesel and electric

passenger trains. In addition, at this plant, visited the Car Research Institute, which is operated as a branch of the All-Union Diesel Locomotive Research Institute.

In the evening, left Riga on an overnight train trip to Leningrad.

Wednesday, August 10

Arrived in Leningrad in the morning and toured the Predportovaya refrigerator car shop, which is located on the outskirts of the city and is one of ten refrigerator car maintenance facilities serving the Soviet railroad system.

Thursday, August 11

Observed repair operations at the freight car repair depot adjacent to the Leningrad classification yard and talked with depot personnel. Later, visited the Railway Engineering Institute, which is the second largest of the country's 15 transportation institutes for railway engineering.

Friday, August 12

Visited the Yegorov car manufacturing plant, which now specializes in the production of subway cars.

In the evening, was taken to the ballet.

Saturday, August 13

Spent the day sightseeing in Leningrad, including a tour of the Hermitage. In the evening, left by overnight train for Moscow.

Sunday, August 14

Arrived in Moscow in the morning and later went sightseeing. In the evening, attended a performance of the Moscow Circus.

Monday, August 15

Attended a final session with officials at the U.S.S.R. Ministry of Railway Transport; this included the formal signing of the record of proceedings of the sixth meeting of the Joint American-Soviet Railroad Working Group.

In the evening, left Moscow for the return trip to the United States.

APPENDIX D

GENERAL NOTES AND OBSERVATIONS ON NONTECHNICAL ASPECTS OF VISIT

At each of the three railroads visited, the U.S. delegation noted that, at two or three o'clock in the afternoon, it was customary for the Soviet hosts to break off the business discussions in favor of a rather lengthy lunch. It was also interesting to observe that members of Soviet labor organizations frequently joined railroad management personnel at such lunches with the U.S. delegates. During the lunch, the exchange of information would continue, but on a more generalized and less technical level.

At one of these lunches, for example, we had a broad-ranging conversation that touched upon many aspects of railroading in both the Soviet Union and the United States and, that, in particular, provided us with some useful background information on Soviet railroad practices. We learned for instance that, as a general rule, about 25 percent of the workers employed by a Soviet railroad are involved in track maintenance, about 35 percent specialize in equipment maintenance, and the remainder are in transportation services. In addition, it became apparent to us that employees who operate locomotives in the U.S.S.R. receive as extensive training as their American counterparts. Furthermore, one supervisor is assigned for every 25 locomotive crews (a total of 50 men) on the railroad, and each time a crew member reports for duty, he is checked by a medical technician to make sure he is in fit condition. We also learned that, on the Soviet railroads, employees are permitted -- but not required -- to retire on a modest pension at the age of 60 for men and 55 for women.

All in all, these nontechnical sessions -- sometimes over a meal and sometimes a conference or simply an informal get-together -- were very useful in providing the delegation not only with information about, but also a deeper understanding of, the railroading environment in the Soviet Union. By the end of our visit, for instance, we had come to recognize that Soviet railroad workers have much in common with railroad workers in the United States.

The Soviet railroad officials gave us numerous opportunities to increase our knowledge of both their industry and country. During the week, they would arrange visits to local railroad and mass transit facilities. For instance, at the conclusion of our first business day in Moscow, we were taken on a tour of one of the city's five passenger stations. It was quite evident during the walk into the general waiting room areas that railroads are the prime means of transportation for the Soviet people. The stationmaster told us that this station handles 40 intercity trains each day, in addition to 140 commuter trains. Also in Moscow -- and later in Kiev and Leningrad, the delegation was able to ride on and inspect the local subway system. In each case, the delegates were impressed with the cleanliness of the stations

and the efficiency of the subway system.

Incidentally, while in Moscow, we were struck by the fact that the city's traffic and smog appeared equal to those of several major U.S. cities. We saw a large number of trucks handling construction material; Moscow, with a population of approximately 7.5 million people, obviously has a great amount of new construction under way.

In each city we visited, the Soviet railroad officials made arrangements for us to spend at least part of each weekend touring the city and visiting local places of historic or cultural interest. On the first Saturday of our visit, though, our hosts -- officials of the South-eastern Railroad -- took us somewhat farther afield than the city itself (Kiev). In the morning, we were taken on board an excursion boat and treated to a 3-hour boat trip on the Dnieper River.

That afternoon, the delegation was taken to a recreational and rehabilitation facility owned by the railroad and set up for the use of the railroad's employees and their families. During the summer, boys and girls aged 7 through 15 can spend 24 days at the Pioneer-type camp, which is equipped with complete medical and dental facilities. The actual cost of maintaining the children at the camp, which is located about 20 miles outside of Kiev, is approximately \$168 per child; however, the parents only have to pay between \$9.80 and \$19.60, with the difference being supplied by the party labor organization.

Later, in Riga, on the Baltic Sea, the U.S. delegation visited another railroad-operated Pioneer camp. Approximately 250 children attend each session at this camp, where they are taught crafts and activities similar to those in our Girl Scout and Boy Scout programs.

On the weekend in the historic city of Leningrad, the delegation attended the ballet, saw the world-famous art collection in the Hermitage, and visited several other historic buildings, including Peter the Great's summer palace. On our final night, we attended a fine dinner hosted by the October Railroad.



APPENDIX E

ENGLISH-LANGUAGE TITLES AND ABSTRACTS OF DOCUMENTS GIVEN TO
U.S. DELEGATION BY U.S.S.R. MINISTRY OF RAILWAY TRANSPORT

During the U.S. delegation's visit, the U.S.S.R. Ministry of Railway Transport furnished a total of 15 documents relating to Soviet rolling stock technology and practices. All of these documents, which are now on file at the Federal Railroad Administration, are in Russian and have not been translated into English. This appendix consists of a complete list of these documents in English, together with brief English-language abstracts (many of which are translations of the original Russian abstracts). For further information, consult the latest edition of the Railroad Research Bulletin (prepared semiannually by the Railroad Research Information Service) or write to the Technology Planning Officer, Office of Research and Development, Federal Railroad Administration, 400 Seventh Street, SW., Washington, D.C. 20590

1. Product Development and Authorization for Its Manufacture. Basic Provisions, U.S.S.R. State Standard 15.001-73, State Committee for Standards, U.S.S.R. Council of Ministers, Moscow, 1973.

Abstract: This official state standard (to be in effect from January 7, 1974, to January 7, 1977) serves as the basis from which Soviet ministries (departments) develop industrial branch and state standards. It establishes the general procedures for the development, coordination, and approval of technical assignments, the appraisal of draft technical documents, the testing of test versions (prototypes), and the conducting of inspection tests of the final products in series and mass production.

Addendum 1 explains the procedure for structuring, elaborating, and drawing up technical assignments for the development and manufacture of products on the basis of documentation corresponding to the requirements set forth in standards of the Unified System of Design Documentation (YeSKD).

Addendum 2 contains similar information for products developed and produced on the basis of technical documentation not containing design documents.

Addendum 3 presents a list of key issues necessitating consideration in the development of standards, as well as in the conducting of inspection testing of series and mass-produced products; it is recommended that these issues also be taken into consideration in the preparation of industrial branch and state standards.

Addendum 4 consists of the recommended requisition form for the development and assimilation of a product.

Addendum 5 provides the form stating the expert's conclusion on the findings of the appraisal of draft technical documents.

Addenda 6, 7, and 8 contain the recommended forms for the report on acceptance tests, the product acceptance documents, and the report of the industrial esthetics council.

Addendum 9 provides the form for the report on periodic tests of products.

2. Alekseyev, V.D., ed., Reference Book on Freight Car Repairs, "Transport" Publishing House, Moscow, 1970.

Abstract: This reference book presents the basic dimensions and weights of freight car parts, standards for consumption of materials, tolerances used in various types of repairs, the defects commonly encountered in freight cars, and methods for their elimination. This third edition of the reference book has been revised to include new types of cars introduced on the railroads and changes that have occurred in the official instructions, rules, and state standards. The reference book is intended for foremen, crew chiefs, and other engineering and technical workers involved in the maintenance of railroad cars.

The chapters in the reference book are (1) Basic characteristics of cars, (2) General information on the maintenance and repair of cars, (3) Wheel pairs, (4) Axle boxes with friction bearings, (5) Axle boxes with roller bearings, (6) Coils and springs, (7) Trucks, (8) Coupler devices, (9) Automatic brakes, (10) Car frames, (11) Car bodies, (12) Electric welding during car repair, (13) Car painting, (14) Containers, (15) Saw timber used in car repairs, (16) Metal products used in the repair of cars, and (17) Basic requirements for cars in operation.

3. Instructions for Operation of Railroad Rolling Stock Brakes, U.S.S.R. Ministry of Railway Transport, "Transport" Publishing House, Moscow, 1974.

Abstract: These instructions establish the requirements and standards for the maintenance and servicing of braking equipment on rolling stock, as well as for controlling the brakes on trains. They constitute the basic guide for the operation of brakes on the railroads of the Union of Soviet Socialist Republics. The chapter headings are (1) The preparation of braking equipment, (2) The procedure of changing control cabins on locomotives and MU trains, (3) Coupling of the locomotive to the consist and testing train brakes, (4) Supplying the train with brakes, (5) Procedure for placing and hooking up automatic brakes on trains, (6) Care of automatic brakes on the move, (7) Brake control on trains, (8) General rules for the preparation of automatic brakes and control of them on freight trains weighing more than

6,000 tons, (9) Engineer actions during a required stop at a siding, (10) Engineer actions when delivering a train to a station after it has been broken up, (11) Brake control when a train is moving with dual or multiple traction, (12) Uncoupling of the locomotive from the consist, (13) Procedure for hooking up automatic brakes on inactive locomotives and cars of MU rolling stock transferred to trains in car groupings and brake control, (14) Operation of automatic brakes in winter conditions, and (15) Brake checks.

4. Gonchazov, V. M., and L. G. Murzin, Fuel, Lubrication, and Water, "Transport" Publishing House, Moscow, 1973.

Abstract: This book is divided into three sections. The first section reviews the classification, composition, and basic properties of various types of fuels, and ways to economize on fuel consumption in diesel locomotives. The second section presents the basic characteristics of, methods of obtaining, and uses for lubricating oils. The third section describes the composition and properties of natural waters, reasons for the formation of deposits and corrosion of metals, methods for the preliminary treatment of water, and methods of preparing water for cooling diesel locomotive engines and feeding steam locomotive boilers. The book has been approved by the main department of educational institutions as a textbook for use in instructing technical students and as a teaching aid for students in technical schools of railroad transportation.

5. Stepanov, V. R., et al., Model 2TE10L Diesel Locomotive, "Transport" Publishing House, Moscow, 1974.

Abstract: This book provides the basic technical characteristics and illustrates the operation of the 2TE10L diesel locomotive. Special attention is devoted to describing the design of the 10D100 diesel engine, the electrical equipment, the underframe, and auxiliary equipment. Examined in detail are the electrical control circuits and the excitation diagram of the diesel locomotive. The first edition of this book was issued in 1970. This book is intended for engineers and their firemen and also can be used as a textbook by students in technical schools and engineer-training schools.

6. Barteneva, L. I., et al., Design Specifications for Two-Axle Freight Car Trucks for Long-Term Usage Conditions, Works (Technical Papers) of the TsNII MRT, Issue Number 483 (1973).*

*TsNII MRT = All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport of the U.S.S.R. Ministry of Railway Transport

Abstract: An analysis is given of existing designs and trends in the modern design of freight car trucks. Criteria are formulated for making engineering estimates of the running gear of cars. The results are given of studies of the dynamics of freight cars for the purpose of improving their running and operating properties for increased speeds. Recommendations are given on the selection of key parameters for two-axle freight car trucks. The material presented in this monograph will be useful in solving problems in improving the design of modernizing running gear of existing cars, taking into account long-term usage conditions.

The technical papers included in this document are (1) Criteria for estimating dynamic properties and performance of freight car trucks; (2) Dynamic properties and performance of the TsNII-Kh3-0 trucks and improving the design of four-wheel trucks; (3) Theoretical studies of the dynamics of freight cars and selection of key parameters of running gear; (4) Selection of spring suspension parameters for the purpose of reducing the rate of lateral oscillations of cars.

7. Krylov, V. I., et al., Reference Book on Brakes, 3rd edition, revised and supplemented, "Transport" Publishing House, Moscow, 1975.

Abstract: The reference book presents diagrams of locomotive braking equipment, multiple-unit (MU) rolling stock, and cars of the railroads of the U.S.S.R. Presented are the sizes of the basic components and parts of braking equipment subject to wear, repair tolerances established for these components and parts, diagrams of brake rigging standards for calculating the applied force of brake shoes, correlative curves for track braking distance versus speed, the inclination and applied force of brake shoes, and lists and consumption standards for spare parts.

This third edition of the reference book is supplemented with data on new brake apparatus accepted for manufacture, as well as on experimental apparatus in operation, diagrams of brake equipment on new rolling stock, comparative characteristics of foreign brake apparatus, technical requirements for redesigning brake apparatus, and technical conditions for brake apparatus. The sections on apparatus for high-speed trains, electropneumatic brakes, and materials used in brake manufacturing have been considerably expanded. The reference book is designed for engineers, inspectors, superintendents, and foremen involved in brake repair, as well as other engineering technical employees of railroad transportation connected with the operation of rolling stock brakes. In addition, this edition of the reference book has been organized so that it can be used in diploma and course planning.

8. Grudyushko, V. I., ed., Research on the Reliability of Freight Cars and Ways to Increase Their Efficiency, Works (Technical Papers) of the TsNII MRT, Issue Number 524 (1974).*

Abstract: Presented are the results of theoretical and experimental research on the effect of operating conditions on the efficiency and technical condition of freight cars. Described are the methods and results of research into the reliability and technical condition of freight cars under general-purpose operating conditions. Provided are recommendations for further improving the system of routine maintenance and preparation of cars for shipments on an industrial basis. Presented is the methodology for evaluation of the capability for increasing the car in service time without having to stop for inspection and repair, as well as determination of the optimal length of a nonstop movement sector. The book is intended for engineering-technical and scientific workers in railway transportation who are involved with freight car operations and repair.

The technical papers included in this document are (1) Analysis of the technical condition and routine maintenance of freight cars; (2) Research on the effect of operating conditions on freight car efficiency; (3) Research into the reliability and technical condition of freight cars; (4) Improving the system of routine maintenance and preparation of cars for shipments; (5) Research into the dependence of the failure-free operation of cars in trains on the level of restoration of their efficiency at the PTO (inspection point); (6) Substantiation of the capability of increasing the operational duration of cars in trains.

9. Senderov, G. K., ed., Increasing the Reliability and Improvement of the Routine Maintenance of Freight Cars, Works (Technical Papers) of the TsNII MRT, Issue Number 459 (1972).*

Abstract: This proceeding presents 11 technical papers, which are identified below along with short summaries of their contents:

a. "Investigation of the Characteristics of the Evaluation of Freight Car Reliability and the Fixing of Rates for Reliability Indices." (Problems of the theory of reliability applicable to freight cars are set forth. The distinctive features of estimating the reliability and life of cars, of systematizing the gathering of information, and of selecting a proving ground for gathering information are examined. Particular aspects are given of the distribution of car breakdowns resulting from malfunctioning of individual components, as well as the procedure for determining reliability standards for freight cars.)

b. "Towards an Evaluation of the Longevity of Freight Car Center Plates." (A procedure is examined for estimating the life of parts operating under conditions of pulsed compression cycles. Application of this procedure is illustrated through the example of a carbody center plate on a four-axle gondola and calculation is made of the service life of a mass-produced and reinforced plate. Calculated results are compared with service and experimental data.)

c. "The Longevity of Freight Car Truck Springs." (The results are given of studies of the life of new and used freight car truck springs. A discussion is given of the mechanism for buildup of fatigue damage to springs associated with the effect of cyclic loads in the process of use. A demonstration is given of the effectiveness of intermediate shot peening to increase the life resource of springs.)

d. "Problems in the Evaluation of the Heat Engineering Condition of Refrigerator Cars." (An analysis is provided of current criteria for evaluating the heat engineering properties of refrigerator cars. A summary is given of domestic and foreign experience in the use of thermography. Specifications are formulated for a system of monitoring the heat insulation qualities of cars.)

e. "Problems in the Improvement of Linkless Automatic Regulators of Brake Rigging." (Questions are addressed relating to interaction of automatic regulator components, taking into account established tolerances and characteristics of springs. Calculations are given for the stability of the return spring and the stressed state of its supporting coils. An analysis is made of the geometrical dimensions of adjusting screws and a determination is made of the conditions that permit proper operation of the screw and the automatic controller's mechanism.)

f. "Theoretical Research of the Stress-Deformed Condition of Open Box Car Unloading Hatch Covers." (Questions are dealt with relating to calculating stresses and strains in hatch covers. A procedure is given for calculating the operating reliability of a hatch cover.)

g. "The Effect of Some Design Parameters and Operational Tolerances on the Reliable Movement of a Freight Car." (The results are given of theoretical studies of the influence of a freight car's parameters on stability of movement on turnout curves of a section of track as a function of the gap between truck side bearings, the rigidity of the spring group, the carbody, and the rail. A calculation is made of the lower limits of total play between side bearings for cars of different types.)

h. "The Method for Calculating a Plan for Introducing and Organizing the Work of Bearing Shops in Car Depots." (A procedure is developed and presented for devising a schedule for introducing bearing shops at car depots from the viewpoint of economic feasibility. Estimates are made of production areas required for bearing

*Ibid.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

14. "Results of Preliminary Tests of the (U.S.) Westinghouse Company's Type H-60 Draft Gear," Unpublished paper, U.S.S.R. Ministry of Railway Transport, Moscow, 1977.

Abstract: Described are the procedures used to carry out tests on a type H-60 Westinghouse Company draft gear furnished to TsNII (the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport) of the U.S.S.R. Ministry of Railway Transport. The performance characteristics are given of the draft gear subjected to a variety of static compression tests, as well as the conclusions derived from these tests. The analysis performed on data from dynamic tests of the draft gear mounted on an eight-axle tank car and a four-axle gondola is used to arrive at conclusions regarding the power rating demonstrated by the apparatus for initial closing and rebound during coupling. Suggestions are given for additional testing and the study of the H-60 draft gear.

15. "Measures for Ensuring the Normal Operation of Diesel Locomotive Cooling Systems Under Winter Operating Conditions," U.S.S.R. Ministry of Railway Transport, Moscow, 1977.

Abstract: Given are the measures and recommendations developed at TsNII (the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport) of the U.S.S.R. Ministry of Railway Transport for the prevention of failures of air-oil cooling systems on paired-unit TE3 diesel locomotives in winter time. Design modifications made on the TE3 diesel locomotive for operating in very low temperatures are described; the principle employed is to raise the temperature of the ambient air around the cooling system by means of mixing cold outside air with air heated in the cooling system and blown by the ventilator. Provided are additional technical requirements developed for the operation of air-oil cooling systems with hydrodynamic and hydrostatic driven fans on 2TE10L and TEP60 diesel locomotives with outside temperatures as low as minus 55 degrees C. Findings from tests on a TE3 diesel locomotive are given; this locomotive is one of a series on which a mechanism is used to reduce rarefaction in the diesel compartment and engineer's cab.

14. "Results of Preliminary Tests of the (U.S.) Westinghouse Company's Type H-60 Draft Gear," Unpublished paper, U.S.S.R. Ministry of Railway Transport, Moscow, 1977.

Abstract: Described are the procedures used to carry out tests on a type H-60 Westinghouse Company draft gear furnished to TsNII (the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport) of the U.S.S.R. Ministry of Railway Transport. The performance characteristics are given of the draft gear subjected to a variety of static compression tests, as well as the conclusions derived from these tests. The analysis performed on data from dynamic tests of the draft gear mounted on an eight-axle tank car and a four-axle gondola is used to arrive at conclusions regarding the power rating demonstrated by the apparatus for initial closing and rebound during coupling. Suggestions are given for additional testing and the study of the H-60 draft gear.

15. "Measures for Ensuring the Normal Operation of Diesel Locomotive Cooling Systems Under Winter Operating Conditions," U.S.S.R. Ministry of Railway Transport, Moscow, 1977.

Abstract: Given are the measures and recommendations developed at TsNII (the All-Union Order of the Red Banner of Labor Scientific Research Institute of Railroad Transport) of the U.S.S.R. Ministry of Railway Transport for the prevention of failures of air-oil cooling systems on paired-unit TE3 diesel locomotives in winter time. Design modifications made on the TE3 diesel locomotive for operating in very low temperatures are described; the principle employed is to raise the temperature of the ambient air around the cooling system by means of mixing cold outside air with air heated in the cooling system and blown by the ventilator. Provided are additional technical requirements developed for the operation of air-oil cooling systems with hydrodynamic and hydrostatic driven fans on 2TE10L and TEP60 diesel locomotives with outside temperatures as low as minus 55 degrees C. Findings from tests on a TE3 diesel locomotive are given; this locomotive is one of a series on which a mechanism is used to reduce rarefaction in the diesel compartment and engineer's cab.