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CHAPTER 4

An Analysis of Soviet Railway Operation

The Nature of Soviet Railway Operations

USEFULNESS OF STUDY

Of the several forms of transport, the railways alone afford a body of interrelated data that permit some internal check upon the probable accuracy of the published figures and also make possible an analysis of the methods by which the traffic performance is achieved.[1] Moreover, at least something is known of the source of many of these data; hence an impression can be formed of the character of the error which they may reflect and occasionally some judgment of its magnitude can be risked. This is of particular importance since the railways account for by far the greatest part of freight and passenger traffic and it is around the railways' returns that there has been the greatest controversy in Western countries.

Distrust has been generated by performance factors, particularly car turnaround, which may be viewed as impossible by Western standards. But, in general, the superficial picture is one of a traffic so large as to be inconsistent with the relatively small railway plant operated—small in mileage as well as in motive power and equipment. Characteristically this is interpreted in the West as a sign of weakness, despite the considerable period over which it has persisted without significant breakdown of performance. Moreover, the Soviet railroads have been judged by Western standards and found wanting in efficiency because they employ obsolescent motive power and equipment, render a service wanting in accommodation to shippers' desires, and show a low labor productivity. The question may be raised, however, whether these standards are appropriate to the Soviet scene in the light of over-all Soviet objectives. Moreover, economic inefficiency reckoned in Western terms, if it can be shown to exist, casts little light on (1) the physical capability of Soviet transportation which should be a prime interest of Western students when appraising the military capability of the Soviet Union or (2) the adjustment to patterns of resource availability as they have existed in the Soviet Union during its progress from a state of economic underdevelopment. Hence we must embark upon our examination from a somewhat different point of view.

[1] It may also be re-emphasized that they account for from 89 to 90 per cent of Soviet intercity freight traffic as well as for the great bulk of the passenger traffic.

RELATIONSHIP OF RAILWAY DEVELOPMENT TO THE ECONOMY AT LARGE

A plausible argument can be made for the proposition that the Soviet railways have gone through three decades of development in which their course has been charted and held in good correlation with the over-all Soviet economy. If one postulates a situation in which: (1) labor is plentiful, but labor with good mechanical skills scarce; (2) engineering personnel is limited, but more by the quality of its training and its experience than by number; (3) heavy industry is inadequate for the demands made on it and there is a marked shortage of capacity to produce the heavy shapes and forms of steel that railroad development requires, and an even more marked shortage of heavy machining capacity to work to close tolerances; and (4) transport is to be regarded as a necessary service for industrialization, but is to be used in such a way as to make the minimum drain on all that is necessary for that industrialization, not in monetary terms but in physical resources and available human skills—then much that has occurred in the Soviet railways finds a ready justification. There are now signs of change that suggest that the balance of economic forces has altered sufficiently to make possible movement in directions already pursued in the West. These signs are to be found particularly in the refinement of steam motive power, the beginnings of dieselization, the planning of more extensive electrification of strategic routes, and developments in signaling and in the mechanization of yards. These developments suggest that concern over the inadequacy of petroleum resources has diminished, that labor has become less plentiful, and that the level of mechanical and engineering skills has improved. Of what, then, did this adjustment to Soviet conditions consist?

It has been said that the Soviet railways in recent years bear a marked resemblance to the North American railways of the early 1920's. There is an element of truth in this statement, but it cannot be accepted without qualification. Like American railways in the period before highway and air competition, the Soviet system is established upon the basis of moving tonnage in slow freight service, but there is even less differentiation in Soviet freight service than on the American railways of earlier times, for interrailroad competition is absent and, beyond what is necessary to the security of perishables, little concession has been made toward provision of fast freight services. To maximize line capacity, the objective is to operate a railroad at as nearly a constant speed as possible.

Any transportation system may be analyzed in its adjustment to the needs of the shipper in terms of three primary dimensions: the rates charged for specific services; the over-all speed between points; and the service amenities, which include frequency, reliability, size of shipment permitted, special parcels facilities, split pick-ups and deliveries, expediting, diversion and reconsignment privileges, and the privilege of holding for billing and other matters.[2] As already noted, the Soviet rate system is used as a tool to accomplish certain objectives. But relative to other prices, Soviet freight charges as measured by average revenues appear to surmount efficiently the barriers of distance in terms of cost. At the distances within range of average hauls, cost of transportation appears reasonably related to other costs. In average speed of movement the Soviet system also shows up well. While train speeds between initial and final terminals, including all delays on the road, do not compare favorably with present speeds in the United States, they are offset by faster movement through yards so that Soviet over-all times correspond well with those for similar hauls in the United States. Under the head of service amenities, however, virtually nothing is provided except, over most main routes, a high frequency of freight train service which arises naturally from the high density and concentration of the freight traffic and the relatively light net train load. By ignoring amenities that are forced upon carriers in a competitive system, Soviet railroads simplify their task considerably. And they go even further in this respect than the railroads of other countries in an earlier era, for they provide virtually no accommodation for the less-than-carload consignment and for peddler services,[3] thus forcing concentration into carload consignments and avoiding the waste of cars inherent in lightly loaded less-than-carload business.[4]

In the production of mass slow-speed freight transportation, the Soviet roads have worked with simple but rugged plant and have carried standardization to an extreme degree. For over twenty years three standard types of steam freight locomotive have represented virtually all the additions and replacements in the freight locomotive fleet, while two types of steam passenger power have sufficed for most needs, and special designs for switching work have not been required.

[2] The Soviet system escapes some of the complexity of a competitive system for, where it is necessary to hold a bank of cars at a port, segregation by large numbers of individual owners as well as by grade is generally not required.

[3] Peddler services consist of the delivery of less-than-carload consignments at intermediate stations from cars moving in local freight trains.

[4] The small two-axle car is, of course, very handy for smaller consignments within the range of its capacity. Some recent emphasis upon the necessity of improved service for small consignments appears to have been dissipated.

Major parts are interchangeable between the heavy freight and the heavy passenger power. Freight car types are distinctly limited in number and new construction has been consistently restricted to a very small number of standard designs. The variety to be found in the whole system is rather less than any individual large American railway would boast of, particularly in dimensions and door arrangements of box cars and dimensions and special equipment of gondolas. The specialized car finds no favor on the Soviet roads and is provided only as necessity dictates, e.g., in tank cars and refrigerator cars. Standard all-purpose cars are made do where shippers in a competitive economy would require better adjustment to their needs and would secure it. The standard open gondola serves not only bulk loadings but also much traffic which in the West would be loaded in covered cars. This lack of specialized cars is very helpful in keeping empty car-mileage at a low figure.

Soviet locomotive practice, as much as anything else, illustrates the adjustment of railroad equipment to the general economic position of the country. The freight power is generally of the 2-10-0 and 2-10-2 types, small wheeled, small boilered, worked at low pressure, and of simple and rugged design.[5] Such power with bolted bar frames and cylinders and saddle separately cast imposes minimum demands on manufacturing facilities and requires limited skills of a good part of the mechanical department force,[6] while the relatively small size of power and its high degree of standardization hold down the machinery and stock requirements of running sheds and back shops for maintenance and repair. Power is intensively used and mileage between heavy repairs is not good, which may reflect both the quality of materials used and the character of the work performed. But the entire problem of supplying and maintaining power with limited skilled forces on which to draw is vastly simplified by such a standardization over long periods on power which the West regards as obsolete[7] because of high

[5] Dimensions of all principal types in general use are given in Henry Sampson (ed.), *World Railways,* London, 1952, f.c. 124. See also P. E. Garbutt, *The Russian Railways,* London, 1949, p. 50.

[6] Such frames are bolted together from relatively small rolled bars, while each cylinder may be a separate iron casting and the saddle, cast in one or two pieces, holds the cylinders together and ties them to the frames and the front end of the boiler. By contrast, U.S. practice in the last twenty years of steam locomotive production puts the whole assembly into a single massive steel casting sometimes weighing over a hundred tons.

[7] Between 1938 and 1948 kilometrage between classified repairs for freight power increased from 32,381 to 43,500, while for passenger power it increased from 47,336 to 59,700. The average heavy repair in 1946 required 33.3 days while the average medium repair required 29 days. Heavy classified repairs were shown to include tires, bearings, machinery, cylinders, boiler, and firebox.

fuel consumption, small capacity, inadequate boiler horsepower for sustained high speeds at full tonnage rating, and heavy maintenance cost.[8] Such power is generally hand fired and the common road crew is composed of three men (or women).[9]

While the standard types have been retained, considerable modernization has been accomplished without introducing undue complexity or a very high level of technology. Greater speed, without damage to track, on power having fifty-two-inch and fifty-nine-inch wheels has required the reduction of dynamic augment, which has been accomplished through the introduction of several patterns of disc wheel centers resembling designs used earlier in the United States, while some effort appears to have been expended to lighten rods and valve gear assembly.[10] Coal and water stops have been reduced by the gradual use of larger tenders as well as of condensing tenders in desert country and in areas with bad water. Boiler performance has been improved through the introduction of superheater units comparable to the Elesco Type E and of thermic siphons and exhaust steam injectors on some of the more recent power. Compounding has generally been avoided, while liberal clearances have enabled cylinders and motion work to be kept outside the frames, thus avoiding the maintenance complexities associated with three- and four-cylinder power. No form of articulated[11] power has been in service on more than an experimental basis. Double heading has been preferred to the complexities of large power, although the very flexible Beyer-Garrett has been tried and presumably performed according to its accustomed high standards without, however, commending itself for adoption under the conditions imposed by the Soviet system of maintenance. It is interesting to note that articulation is featured in two recent designs of large steam power, presumably experimental. The articulation is as used in Mallet engines, but the locomotives are not compounded.[12]

8 This last is largely a reflection of manpower inputs.

9 By contrast, Soviet freight trains carry no cabooses and a single conductor makes up the rest of the crew.

10 After 1915, U.S. freight power generally had wheels of sixty-three-inch diameter or larger.

11 An articulated locomotive is one that employs one or more steam engines coupled to driving wheel sets which are connected to the main frames by pins and are thus permitted to move laterally on curves.

12 These types show a strong resemblance to U.S. types developed in the late 1930's and built in some number immediately before and during the second war. They are of 2-6-6-2 and 2-8-8-4 wheel arrangements. In view of the shift to diesel now under way, they will presumably not be duplicated.

In the last few years progress has been made in shifting to diesel power in desert country and on some lines of difficult profile,[13] and much more electrification and dieselization is planned under the present seven year plan, so that diesel and electric power will replace steam over the greater part of the system.[14] Whereas a desire to avoid dependence on petroleum fuel has been argued in the past as standing in the way of dieselization, it appears probable that the creation of an adequate maintenance force of the higher and more varied skills required has also stood in the way and is only now being overcome.[15] The advantages of diesel power on lines which permit only a light axle loading and yet have relatively heavy grades are especially great and the adoption of such power may avert the necessity to electrify certain routes where the traffic density appears hardly adequate to support the overhead installations necessary for electrification.[16] On such routes dieselization may produce virtually the same increase in line capacity that could be secured from electrification and it will tend to be done under Soviet conditions less for reasons of operating economy than for increasing the capacity of the line without the necessity of laying additional running track. Nevertheless Soviet analysts place a good deal of emphasis on the prospect of economy and their estimates closely resemble those made in the United States to support the shift to diesel power.[17]

Soviet planning and accomplishment in railway line have shown similar characteristics. Nowhere is there an attempt to promote economic growth through the prior provision of transportation. The idea that settlement and development will follow the construction of a transport system is, as far as possible, reversed. Railroads are looked upon as devices to secure particular objects; hence, whereas the light density of line within Soviet territory as it emerged from the revolution might have suggested a vast expansion to open out new territory,

[13] Profile refers to the combination of gradients over a line of railroad.

[14] The proportion of road freight service worked in steam declined from 89.8 per cent in 1954 to 66.5 per cent in 1959.

[15] The strictures on petroleum fuel appear to have been considerably relieved. An extensive training program to improve the skills of the mechanical force has been required.

[16] Available illustrations and the report of the recent railway mission both indicate, however, that a lighter catenary is used than is acceptable in U.S. practice. Hence the investment requirements per mile of electrified track are presumably lower and the break-even density correspondingly lower. (See *Railway Age,* August 1960, p. 14.)

[17] These analyses have been explored by James H. Blackman and are discussed at some length in his *Transport Development and Locomotive Technology in the Soviet Union,* Columbia, S. C., 1957.

nothing of the sort has occurred. Projects have received careful scrutiny in the light of proposed mineral exploitation, industrial construction, and agricultural development. Maximum use has been made of available waterways in territory not yet penetrated by railroads. Roads and even air transport serve where the volume in immediate prospect does not justify the heavy investment of metals required for minimum standard railroad construction. And this is as would be expected in opening up new territory where the modern variety of means of transport is available, although the calculations employed elsewhere would differ in detail, particularly as to what corresponds to the rate of interest.

The railroad system of Russia, though in considerable part privately developed under the tzars, was never a competitive system. It was planned to meet the more urgent requirements as evaluated by the government in a nonduplicative system and the private portion was developed under a system of concessions somewhat similar to that in France. An integrated network of thin coverage, relatively bereft of feeders except in the mineral districts, resulted. Before the first war roughly two-thirds of the system was owned and operated by the government, and Splawn reports an apparent tendency toward private ownership subsidized and supervised by the government.[18] Notwithstanding the planned character of the system and its lack of duplicative and competitive trackage, its freight traffic density had not quite developed by 1913 to the density of the U.S. network.[19]

The Soviet pattern of development has been wholly intensive, not extensive. Primary attention was placed upon strengthening the more important select main lines of the existing system with a view to concentrating the heavy traffic flows on them. Such routes were given additional second main track, passing sidings, and signal facilities, and were laid with heavier rail on improved roadway; in some instances, grades and curvature on them were ameliorated. Important yard expansion was necessary to permit these lines to operate at something approaching a constant twenty-four-hour tempo, for the presence of traffic that was pressing upon facilities and could be moved without taking account of commercial conditions enabled these lines to handle several times the train density that might congest a similar line in another country, provided the yards were made adequate. The absence

[18] W. M. W. Splawn, *Government Ownership and Operation of Railroads*, New York, 1928, p. 109.

[19] The Russian system carried 940,000 net ton-miles per mile of road compared with 1,190,000 net ton-miles per mile of road in the U.S.

of fast passenger trains was important since it greatly reduced the passes required. Heavier power, four-axle freight car equipment, and cars equipped with air brakes or with air lines were also concentrated on such line segments to permit heavy train loads relative to the system average.[20]

Wherever possible, improvement of existing lines with a minimum of new construction was relied upon to accommodate new and growing industrial areas. Certain cut-offs were constructed to eliminate circuitous movement of important volumes of freight. Other line developments were keyed to economic developments that could be anticipated to produce such volumes of freight traffic as to necessitate railroad connections. Most segments of the existing system became more useful as commodity exchange relationships developed and industrialization progressed. Hence there was a general increase of density, but with a remarkable concentration over the routes planned and developed for heavy traffic movement. As long as congestion of junctions, yards, and terminals is avoided, the favorable effect of this concentration on the efficiency of car movement and car distribution is marked. In appraising results, it must be constantly remembered that between all points there is no competitive routing whatever; that the traffic is normally concentrated over the best-developed direct route; that the volume is sufficient with such concentration of routing to permit early preblocking of trains and often the assembling of trains which can move considerable distances without reclassification (i.e., main trackers); that a shipper's traffic between two points is never distributed over a number of competing routes but instead may be assembled over a period of days, although not loaded into cars, for a multiple-car movement; and that as freight cars comprise a single

[20] The performance of the Soviet system from the re-establishment of the prewar level in 1926 through 1935 when the "transportation crisis" was under way is reminiscent of the Pennsylvania Railroad east of Pittsburgh and Erie during its intensive development from 1900 to 1907, but represents a greater intensification of freight working. The Pennsylvania at the start of the period was, however, probably the most highly developed railroad in the world at the time. The data are:

	Soviet System	Pennsylvania
Increase in first main track	13.5%	6.8%
Increase in ton-miles	275.0%	81.0%

In 1900 when the Pennsylvania's intensive development was about to get under way, its freight density per mile of line was slightly over 3,200,000 net ton-miles per annum, or more than the Soviet density of 1935. When 1907 brought a break in business, the road was equipped to handle higher traffic levels than were actually achieved so far as main trackage and yards were concerned. Pennsylvania's heaviest and standard freight power then was class H-6sb with a tractive effort of 42,500 pounds, some 20 per cent lighter than the standard Soviet power of the thirties.

pool and represent only a slight diversity of types, empties can be distributed without regard to diverse ownerships and types over the most direct routes, thus holding empty car mileage to a minimum.[21] Unhappily the poor mechanical condition of equipment and inadequate inspection at initial terminal too frequently result in the breaking up of maintrackers through the loss of bad-order cars and a filling out of tonnage with other classifications at intermediate points.

Although administrative complexities and deficiencies detract from these advantages, their influence on the operating results must be judged to be very substantial. The key role of yards and terminals in a scheme designed to secure such intensive employment of main trackage explains the vast amount of interest in recent Soviet literature in yard layout and design, yard equipment, and efficient yard operations, and explains also the extensive yard improvement throughout nearly the whole Soviet period.

To economize material, axle loads and speeds have been kept within limits that permit the use of relatively light rail section without an excessive rate of wear, and, as Hunter has pointed out, trains of relatively light weight and moderate speed have been run more frequently.[22] Russian motive power generally does not exceed an axle load of twenty-one tons, the type LK being an exception that is employed in small numbers and only on a limited route mileage. By contrast, heavy American steam freight types generally exceeded thirty-ton axle loading and, in some of the heaviest, exceeded thirty-seven tons.[23] The operation of such heavy power at high speeds, even with large-diameter wheels and good counterbalance, caused severe rail wear and promoted rapid fissure growth even in 132-pound rail section.[24]

Light axle loads and the absence of articulation of course result in locomotives of somewhat limited tractive effort, the heaviest Soviet steam freight power in general use developing 64,790 pounds of

21 The common use of open-top cars, particularly low-sided gondolas, for commodities which would be loaded in box cars in this country, permits the development of return loads. Planned interchange of bulk commodities commonly loaded in open tops also sometimes facilitates the avoidance of empty car-mileage.

22 Holland Hunter, "How the Russians Run Railroads," *Railway Age*, August 30, 1954, pp. 24 ff.

23 In the Pennsylvania Railroad class Q-2, just over thirty-nine tons.

24 Soviet rail section on Class I lines is generally 91.5 pounds, the interim standard adopted in 1935, but rail up to 131 pounds has been laid. The average main-line track is of less substantial construction and the characteristic slow-speed operation with light power permits low standards for line and surface, hence characteristically rough track. The want of adequate ballasting and drainage, however, necessitates high labor inputs even to maintain these low standards.

tractive effort compared with 72,000 to 156,000 pounds for heavy American steam freight power. The bulk of Soviet freight traffic is handled by power of approximately 53,000 pounds of tractive effort. But where labor is plentiful and train speeds low, the operation of frequent light trains can expedite car movement without noticeable disadvantage up to the point of line congestion. And it must be borne in mind that, apart from track, the greatest investment of steel in the railroad plant is in its car stock so that a saving of cars through faster handling is of particular resource significance. Although the Soviet Union relies heavily upon composite construction in gondola and closed cars, thus avoiding a heavy requirement of plate by substituting wood sheathing, the principal weight of steel is in car trucks and underframe and cannot be dispensed with.[25] It is from this heavy steel requirement and the accompanying necessity to expand heavy casting, rolling, and forging facilities that the extreme pressures to economize the use of freight cars apparently derive. As will appear, the Soviet railroads and the ministry have deceived themselves and the public, for their active fleet of freight cars is not as small as represented by their data and in consequence the car turnaround is not as fast as reported. In addition, there are important exclusions from the active fleet. Nevertheless performance measured by this datum is excellent when judged by Western standards of experience.

Soviet Use of Plant and Equipment

INTENSIVE UTILIZATION

There are four principal categories of plant and equipment employed together in a railroad operation: permanent way, yards and terminals, motive power, and cars. To these must be added the facilities necessary for inspection, servicing, and running repair. Soviet practice is generally designed to make intensive use of all elements of plant and equipment and has been under continual pressure to handle burgeoning traffic and to hold investment to a minimum. To meet effectively the requirements made of it by the traffic, any railroad operation must achieve a balance among the elements of plant and equipment, but that balance may differ from one railroad to another depending upon the needs of the service. At any time the proportions of the plant relative to the traffic load may bring alterations in the manner of its working.

[25] Car trucks fabricated out of bars continue in use, however, although completely replaced with cast steel side frames in the United States.

The available Soviet operating statistics are less complete than those of the United States, although they include some items which are unknown here, but they do comprise data from which important operating averages can be computed and they enable a general impression of the operation to be secured. For our purpose, which is to confirm the possibility of achieving the recorded traffic performance with the available plant and thus gain assurance of the usefulness of the traffic data as an indication of economic growth, they are reasonably adequate. Nonetheless, it will be necessary to resort to speculation in reviewing these data in order to judge their meaning. And, as noted in Chapter 2, great caution should be observed with the operating statistics given in Appendix A on which we shall have to rely. A variety of methods has been employed in calculating certain approximations in the basic series on varying but often scant evidence and on occasion interpolation has been resorted to in order to chart what appears to have been the probable course of events. Always it should be borne in mind that the quality of service rendered by the Soviet railways differs substantially from that in Western countries and when comparisons are made with U.S. performance it should be noted that our railroads perform a substantial storage function and certain marketing service functions that are not regarded as within the realm of transport in the Soviet Union.

PERMANENT WAY

The relatively high freight traffic density per mile of line recorded in the late 1930's for the Soviet system aroused some skepticism.[26] What, then, must be said of a density which appears to have stood in 1954 at 59 per cent above the prewar peak of 1939? If comparison is made with average freight densities in other parts of the world, the Soviet performance appears improbable; but it is characteristic of most Western systems, and of the U.S. railways in particular, that they have much greater mileage of a character that seldom exists in the Soviet system and that, where they have been developed on a competitive plan as in North America or Great Britain, there is much duplication of main lines and considerable overbuilding. Nor has any large railroad system elsewhere so nearly made maximum use

[26] It is to be recalled, however, that, as pointed out in Chapter 2, Soviet tonnage originated is most certainly overstated and, as appears in Chapter 3, the overstatement is probably greatest for some of the long-haul commodities moving in closed cars. This may produce a greater overstatement of ton-kilometers than of tonnage. In any event traffic density when measured in ton-kilometers per kilometer of line is overstated in consequence.

of main-line trackage by not operating exceptionally high-speed trains and by avoiding the bunching of trains at particular hours according to the needs of traffic and in disregard of the commercial convenience that carries much weight in a competitive system. As Sir William Acworth puts it, "no one needs to be told that the running of trains at varying rates of speed diminishes enormously the carrying capacity of a line."[27] Nor need one doubt that extensive multiple tracking and improvement of signaling have been forced in the United States, not by the amount of traffic to be dealt with in twenty-four hours, but by the bunching of a good part of the day's traffic over certain sections of the line in a limited span of hours. This happened because of the necessity to schedule arrivals and departures of freight as well as passenger trains to meet the public convenience under pain of losing the business to a more accommodating competitor.

Operating statistics on a uniform and comprehensive basis began to be compiled for the U.S. railways during the first war under the aegis of the U.S. Railroad Administration. Reverting to the returns of 1923, when the postwar depression and the shopmen's strike had been overcome, we may indulge in a few comparisons with a period when the American lines operated almost wholly on steam power[28] (much of which was roughly comparable in tractive effort to the heaviest of Soviet motive power) at roughly comparable freight train speeds and without the especially fast long-distance freight and passenger trains of more recent years.[29] In November of 1923 the average density (net ton-miles per mile of road per day) for large steam railroads (excluding the Long Island) ranged from 2,289 for the Denver and Rio Grande Western to 30,872 for the Pittsburgh and Lake Erie.[30] If the November density were multiplied by twelve, bearing in mind the tendency for growth to obscure seasonal variance in the Soviet case, and employing November in preference to the October peak month, we would obtain the following comparisons:

Net Ton-Kilometers per Kilometer of Line per Year			*Net Ton-Miles per Mile of Line per Year*	
Soviet system	1939	4,570,000	Pennsylvania RR	4,659,955
	1954	7,134,000	Pittsburgh and Lake Erie RR	11,268,280
	1958	10,672,000	Erie Railroad	5,322,065

27 William Acworth, *The Railways of England*, London, 1899, p. 399.

28 A small electrified freight service existed on the New Haven, Norfolk and Western, Virginian, and Milwaukee. Diesel power was as yet unknown.

29 It should not be supposed that even in 1923 the quality of American passenger trains in speed was as poor as that of the Soviet system today.

30 The respective October figures were 2,613 and 36,419. (Interstate Commerce Commission, *Operating Statistics of Large Steam Railroads*, October and November 1923.)

In November 1923, 20,538 miles (roughly one-seventh) of the United States system had densities exceeding those of the Soviet system in 1939, but no large railroad had exceeded the density which the Soviet system achieved by 1954, since the Pittsburgh and Lake Erie was a property operating only 231 miles of road, almost all of which was mutiple-track line.

Our knowledge of the mileage of second and additional main track for the Soviet Union does not extend beyond the late 1930's, except for a few benchmark years. That there has been a good bit of multiple tracking since the war may be inferred from the intensive growth of other elements of plant, and the references to such work in the literature. However, it is impossible to put it into quantitative terms although the 1950 Plan, if realized, would have resulted in about 30 per cent of the system being double tracked. The closeness of the Soviet and Pennsylvania Railroad freight densities shown above suggests a comparison of the trackage position of the two for the respective years.[31] The Pennsylvania System in 1923 had a second main track over approximately one-third of its length, a third track on approximately 8 per cent of its road mileage, and a fourth track on about 6 per cent of the road.[32] In 1938 the Soviet system had a second track over 30 per cent of its road mileage, but we have no definite information about third and additional main running track.[33] Portions of the double track on the Pennsylvania could be accounted as necessary only because of bunched fast passenger schedules and the same was true of portions of its third and fourth track mileage. The position as to main running track was, therefore, roughly comparable. The range of densities on the Pennsylvania main trackage appears, however, to have been much wider than that of the Soviet system, for it had secondary lines of very light traffic as well as densities upon the New York, Philadelphia, Middle, and Pittsburgh Division main lines which never were approached by any portion of the Soviet railroad system.

The year 1952 gives the highest traffic performance of recent years for many of our large railroad systems. In November of that year the traffic density, converted to an annual rate, for 8,723 miles of line in the United States embracing seven separate reporting railroad systems, exceeded the density of the Soviet system. These densities ranged up to 12,960,785 net ton-miles for the Bessemer and Lake Erie, slightly

[31] It should be borne in mind that the passenger traffic density of the Pennsylvania System was in 1923 about one-half that of the Soviet system in 1939.

[32] From the Record of Transportation Lines as quoted in *Poor's, Railroad Section.*

[33] Holland Hunter, *Soviet Transportation Policy,* Cambridge, Mass., 1957, p. 371.

more than one-half of which was double tracked. On 12,072 additional miles of line the U.S. densities exceeded 6 million ton-miles, hence closely approached the Soviet average. It is of particular interest that the New York, Chicago, and St. Louis Railway Co. (almost entirely single track) achieved a hypothetical[34] density of approximately 6 million net ton-miles per mile of road. Other high-density roads which were almost entirely single-track systems were:[35]

Southern Pacific	8,065 miles of line	4,205,895 net ton-miles per mile of road
Western Pacific	1,190 miles of line	3,978,500 net ton-miles per mile of road

Track capacity, of course, is more nearly related to the number of train movements per twenty-four hours than to the ton-mileage put over it. The Soviet system has traditionally run frequent comparatively light freight trains, although average freight trainloads have shown a fairly continual increase. Over the average kilometer of main line, the Soviet system put 6,534 freight train-kilometers in 1939.[36] At the November rate, the Pennsylvania system operated 5,306 freight train-miles per mile of road in 1923. The year 1958 is the last for which we have Soviet data, partly estimated, covering road mileage, average locomotive-kilometers per locomotive day and average number of freight locomotives in service. These data give 9,510 freight train-kilometers per kilometer of road. By comparison, the Cincinnati, New Orleans, and Texas Pacific (roughly two-thirds double track and the remainder single) operated 7,536 freight train-miles per mile of road in 1952, the single-track New York, Chicago, and St. Louis operated 4,164, and the Pennsylvania System as a whole operated 3,490.[37] On the Middle Division the Pennsylvania, during heavy traffic months, has often in the prediesel period exceeded the rate of 28,000 freight train-miles per mile of road per annum handled primarily on the two freight tracks, as the passenger mains were required to accommodate upward of sixty passenger trains per day. A similar rate has been achieved on the double-track line between Wago and Columbia, while over the heavy grades via Gallitzin Summit the movement has often exceeded 100 freight trains per day, for the most part accommodated on the two freight running tracks,[38] despite

[34] That is, twelve times the November figure.

[35] Densities from *Operating Statistics of Large Steam Railroads,* Interstate Commerce Commission, November 1952. Track mileage from *Sixty-sixth Annual Report on the Statistics of Railways in the United States,* Interstate Commerce Commission, 1952.

[36] Computed from series C-22 and C-34 in Appendix C.

[37] *Statistics of Railways in the United States,* Interstate Commerce Commission, 1952.

[38] See Pennsylvania Railroad Company, *Traffic Density Charts by Divisions.*

the necessity for return of large numbers of light engines in helper service. There appears to be no reason to question the practicability, in the light of our experience, of the ton-kilometer or freight train densities reported in the Soviet statistics. The performance is clearly possible upon a road mileage with the proportion of second track indicated under the operating conditions which prevail in the Soviet Union.[39]

YARD AND TERMINAL FACILITIES

No large body of information on Soviet yard and terminal practice has come to our attention, nor has a special effort been made to study this phase of Soviet railroad operations. It is, however, apparent that considerable emphasis has been placed on yard improvements, the analysis of yard operations, and the training of yard and terminal personnel. A considerable analytical and instructional literature, which has no recent parallel in the English language, has appeared but is generally devoid of data on actual yard performance. Large retarder-equipped yards appear to be increasing in number at strategic points where it is possible to concentrate car classification, and added emphasis has been accorded this phase of plant improvement since the war.

On January 1, 1946, there were reported to be 896 division and classification yards on the Soviet rail system, giving an average spacing not exceeding 125.97 kilometers.[40] Since Soviet road freight power is customarily assigned to an engine house and operates out and back with an assigned crew, division points tend to be placed at convenient points for an engine turn. Such divisional yards, in many instances, appear to perform little more work than change of engines and crews, inspection, cutting out of bad-order cars, and adjustment of tonnage. At major classification yards, considerable traffic is often relayed through without the trains being worked, although the cars included in such trains are reported in the count of cars handled. Cars are shown, on the average, to have been detained 6.5 hours in 1940 and 8.0 hours in 1945 in each yard along the route and the total number of such detentions encountered at yards transited in each full car turnaround was 10.7 in 1940 (one each 96.4 kilometers) and 13.2 in

39 It must also be recalled that, as Khachaturov points out, the bulk of the Soviet system is of easy profile and with moderate curvature (see S. S. Balzak, *et al.*, *Economic Geography of the USSR*, New York, 1949, p. 449).

40 D. P. Zagliadimov, *et al.*, *Organizatsiia dvizheniia na zheleznodorozhnom transporte* [Organization of Movement of Railroad Transportation], Moscow, 1947, p. 384. When allowance is made for duplication at junctions, the average spacing is somewhat shorter.

1945 (one each 99.7 kilometers).[41] Detention at major intermediate yards has been steadily reduced as an element in the turnaround of the average car, having declined from 73.7 hours per turnaround in 1950 to 50.0 hours in 1958.[42] The relatively modest detention, by comparison with averages experienced in representative major U.S. yards, would appear to reflect in part the frequent movement in small trainload lots and the absence of extensive branch line and local service and in part the extent of forwarding in full train lots and effective prior classification.

Much has been made in the Soviet literature of the practice of forwarding in solid trainloads from origin points to final destination and continuing emphasis is given to the potential importance of this practice in improving the efficiency of railroad operations. Yet definitive information is conspicuous by its absence. It has been asserted that from 40 to 70 per cent of the total tons originated moves in full trainload lots, but such a statement provides wide margin for speculation.[43] Moreover, it is confirmed only to a limited extent by some other data, notably those on the percentages of coal cars switched at yards in the Donets Basin traffic where one would expect to find opportunities for the forwarding of traffic in solid trains. Traffic planning on a monthly basis does provide for the accumulation of quantities to be shipped between particular installations in order to offer the traffic in multiple-car lots and it provides for the exchange of orders among suppliers to the same end. Certain customary solid train movements are known to exist in the coal, ore, petroleum, and timber trades. As the trainload is smaller and less variable than in U.S. practice and as an effort, lacking in the Western countries, is made to encourage multiple-car movements, it may be concluded that the practice has its effect upon the volume of yard work which must be performed.[44]

Effective prior classification, as distinct from movement in full trains, probably has a greater influence in holding down the volume of switching at intermediate points. The control of traffic by the railroads, the absence of diversity of routing, and the simplicity of the network

[41] *Ibid.*, p. 384.

[42] L. S. Iakubov, *Osnovy zheleznodorozhnoi statistiki* [Principles of Railroad Statistics], 2nd ed., Moscow, 1959.

[43] Tretiakov, *et al.*, *Ocherki razvitiia zheleznodorozhnoi nauki i tekhniki* [Essays on the Development of Railroad Science and Technology], Moscow, 1953, p. 236.

[44] As already noted, however, laudable efforts at origin terminals appear frequently to be frustrated by poor mechanical condition of equipment, inadequate maintenance, and indifferent inspection and servicing.

all contribute to the feasibility of putting cars at or near initial terminals into trains which may be handled without intermediate switching to or near final destination.[45] The only comprehensive and detailed study of car movement on the railways of the United States was made in 1933. A comparison with 1940 Soviet data on yard and terminal delay is shown in Table 17, but it should be noted that the U.S. data, derived from terminated waybills, refer to loaded cars only, while the Soviet data include complete turnaround from one loading to the next. The average Soviet car was yarded less frequently in

TABLE 17

COMPARISON OF ELEMENTS OF TURNAROUND: UNITED STATES, 1933, AND SOVIET UNION, 1940

	United States[1]	Soviet Union[2]
Average haul (miles)	353	823
Miles between yardings	46.7	76.9
Detention at yards and terminals (hours)	53	69.6
Average detention per yard or terminal (hours)	7.3	6.5

SOURCE: Col. 1: *Freight Traffic Report,* 1935, Vol. II, pp. 264 ff; col. 2: Zagliadimov, *Organizatsiia dvizheniia,* p. 384.

comparison with the mileage made. In the light of the different conditions encountered by the Soviet railroads, the difference in average detention does not appear to have been significant. But the effect of fewer yardings in a unified and noncompetitive system is to hold down total detention per car turnaround.[46]

In fixing norms and in pressing for their fulfillment, the Soviet administration emphasizes both an increase in the average trainload and a decrease in the average detention at yards and terminals. If other conditions remain the same, these are opposed objectives and tend to obstruct one another. Unless the volume of traffic for each destination separated in the classification yard increases proportionally with the increase in average net trainload, the improved train loading will be achieved at the cost of increased car detention. If density of

[45] On the inefficiencies which may thus be reduced, see John R. Turney, "The Price of Open Gateways," *Annals of the American Academy of Political and Social Science,* September 1936, p. 22.

[46] It should be noted that evidence appears from time to time that reported average detention is minimized by inflating the car count. It is not known how widespread this practice is, but the incentives for such manipulation are considerable in the effort of yard supervisors to meet their norms. In the United States the methods of determining car count are not always uniform from yard to yard even on the same railroad, but reliance is most commonly placed upon cars dispatched as a method for measuring performance.

traffic, profile, and characteristics of motive power are kept in mind, it would appear that efforts to minimize yard detention have outweighed efforts to improve trainload. However, the immediate postwar increase in average detention may in part reflect improved train loading, although it is much more likely to reflect less effective multiple-car consignments, less complete prior blocking of trains, some degree of general disorganization of traffic movement, and less satisfactory condition of equipment. Computed or reported car turnaround in recent years, taken in conjunction with the average haul, implies great success in reverting to earlier levels of yard detention. It would appear that over most of the Soviet period yard facilities have been kept at a reasonable level of adequacy, save for the period of the early thirties when some evidence of congestion appears as noted in Chapter 2 above.[47]

MOTIVE POWER UTILIZATION

Data on the Soviet locomotive stock, both in total and in composition, as well as on its condition (serviceable, unserviceable, and stored), is so incomplete and conjectural since 1940 as to make it hazardous to undertake an analysis of the efficiency with which the stock is employed. What can be said is almost wholly confined to the stock of road freight locomotives. Nothing of moment is known about the utilization of switching power and little about the use obtained from passenger power. Reference to the notes to the appendix tables on locomotive stock will make apparent the extent to which it has been necessary to resort to estimates computed from operating data, i.e., locomotive-miles derived from train-miles and then divided by average locomotive-miles per locomotive-day to give an approximation of active road freight locomotives. A further difficulty is presented by certain known shifts in the method of reporting and the possibility that other undetected shifts have occurred. Nevertheless some discussion may be useful if its highly provisional character is borne in mind.

As a measure of the intensity of use, locomotive-miles per locomotive-day is commonly employed and, when average train speed is taken into account, this can be converted appropriately into the hours spent on the road by the average locomotive. Comparisons have occasionally been made between these data as reported by United States and by

[47] Like main trackage, yard facilities are no doubt objects of very intensive use. A relatively constant flow of traffic contributes to this end but, at the cost of increased switching engine and yard crew hours, relatively small facilities can be employed to transit a heavy flow of traffic, as differences among American yards abundantly demonstrate.

Soviet railroads—both of which employ a statistic carrying in effect the same title. There is, however, an important difference in coverage and it is impossible to adjust the U.S. statistic to make it completely comparable with the Soviet one. The U.S. datum is computed monthly by multiplying average locomotives (serviceable *and* unserviceable, but not including stored) on line by the days in the month and dividing this product into total locomotive-miles—principal, helper, and light. In the Soviet case, unserviceable locomotives are excluded from the working fleet as well as stored or reserve locomotives, and the excluded unserviceables were adjusted after 1932 to include locomotives awaiting or undergoing boiler wash. A more important difference, however, is that operating averages are computed from actual locomotive-hours in the class of service reported, these data being secured from engine house registers at maintaining engine houses. Hence the statistics are different in kind, and one should expect locomotive-kilometers per locomotive-day in the USSR to be substantially higher than in the United States. Some notion of comparative intensity of use can, however, be secured from comparison of locomotive-miles per active locomotive-day as well as by another approach. Thus an impression of the plausibility of the reported Soviet performance can be formed which makes it possible to judge whether the locomotive fleet, reported for some years and estimated for others, is likely to be adequate to move the traffic shown in the Soviet data. No refined techniques are appropriate to the crude data with which it is necessary to work.

Converted roughly into mileage, the recorded Soviet data for average daily miles per locomotive in road freight service are as follows for selected years:[48]

1930	93	1950	157
1935	118	1951	161
1940	159	1952	165
1945	138	1953	169
1949	145	1954	170

For comparison, certain select railroads in the United States are shown in Table 18 below for various years during the steam era. The roads represent a variety of conditions and the data are for the October peaks of years of heavy traffic. The data for 1922 reflect the shortage of power produced by the shopmen's strike of that year and are generally higher than the adjacent years. The mileages shown have been cal-

[48] See series C-25 in Appendix C for original and estimated data and explanatory notes.

TABLE 18

U.S. LOCOMOTIVE PERFORMANCE, SELECTED YEARS

	Locomotive-Miles per Locomotive-Day 1922	1929	1944	Average Train Speed, 1944 (miles per hour)	Daily Hours on Road, 1944
New York Central	92.2	89.1	121.3	15.5	7.8
Pennsylvania	77.6	75.3	98.9	13.4	7.4
Santa Fe	103.1	111.3	154.9	17.5	8.8
Illinois Central	96.0	95.5	85.3	15.4	5.5
Union Pacific	126.1	141.5	149.2	18.5	8.1
New York, Chicago, and St. Louis			148.3	18.7	7.9

SOURCE: *Operating Statistics of Large Steam Railroads,* October 1922, 1929, and 1944, I.C.C.

culated from the operating statistics and represent locomotive-miles per active locomotive-day (i.e., all locomotives not reported as either stored or unserviceable are counted as active). The 1944 data illustrate what could be accomplished under the heavy traffic pressure of a peak war year and generally give the best results achieved in steam by American railroads.

As the Soviet data compute locomotive-days from the time of locomotives in road freight service, they exclude waiting time beyond twenty-four hours at the dispatching engine house which is included in the locomotive-days from which the American data are calculated. Moreover, pusher locomotives and locomotives in way freight and transfer service are excluded from the Soviet data, these types of service being some in which low daily mileage is normally secured. The Soviet daily mileage is, therefore, to be associated with a larger number of daily hours on the road for the average locomotive. This in turn results from the less inclusive locomotive population employed in the calculation. No comparable American statistic is available as locomotives are handled and reported in a different way in this country.

Soviet statistical instructions call for the systematic passage into depot reserves of locomotives idle more than twenty-four hours and for the transfer to railroad reserves of locomotives idle more than ten days. These locomotives are excluded from the working fleet as are those in process of transfer from one maintaining engine house to another. An effort is apparently made to use locomotive-miles per locomotive-day as a measure of the performance of the operating department; hence care is taken to avoid charging to the locomotive time which instead should be charged to the mechanical department or to a fluctuation in traffic volume.[49]

We may conclude: (1) that there is a difference of definition in the Soviet and American statistics in the face of which we should expect to find the average serviceable Soviet locomotive, not stored or in transfer, to be in use more hours per day than its American counterpart; and (2) that the conditions of Soviet rail operations, particularly the greater freight train density and the lack of daily, weekly, and seasonal fluctuations of the sort familiar to Western countries, permit somewhat greater actual useful hours on the road per serviceable locomotive-day. We are unable to assign weights to these two factors. The higher apparent mileage per locomotive-day is a result of both these factors and need not be regarded as exceptional, much less impossible to attain. We may further conclude that the maintenance of a favorable statistical showing from year to year is in part achieved by manipulation of the road freight locomotive component of the working fleet and that the uniformity in ratio between hours on the road and hours consumed in a full turn (i.e., in the fraction of a day that is spent on the road by the average locomotive) leaves open to suspicion the data which purport to reflect intensity of use.

Composite passenger-ton-kilometers, a representation of total line-haul output obtained by adding passenger-kilometers and ton-kilometers,[50] increased 664 per cent between 1928 and 1953.[51] During the same period the aggregate tractive effort of the inventory fleet of locomotives increased by 196 per cent,[52] while the number of locomotives in the inventory fleet increased 106 per cent.[53] Obviously there has been a remarkable intensification in motive power use if these data are even remotely accurate, despite the fact that self-propelled electric multiple-unit trains have accounted for much of the increase in passenger-miles.

In the United States since 1929 there has been a decline both in the number of locomotive units and in the aggregate tractive effort. The period since 1945 has been marked by rapid dieselization and, as tractive effort provides a much less reliable measure of the capacity

49 Careful instructions for the proper assignment of a day's locomotive time between operating and mechanical departments and the reserves are given in Iakubov, *Osnovy zhelez. statistiki,* pp. 168 ff.

50 Common U.S. practice is to treat each passenger-kilometer as the equivalent of two ton-kilometers, although some studies employ the ratio of average passenger-mile revenues to average ton-mile revenues.

51 See series C-38.

52 See series C-24.

53 See series C-23.

of diesel than of steam power, comparison of years since that date with earlier years becomes less useful as the share of diesel power increases. As U.S. railroads now perform virtually 100 per cent of their work with diesel or electric power, direct comparisons of U.S. and Soviet locomotive performance for the last five or six years are not feasible. Certain comparisons up to 1947 will, however, give a rough idea of the relationship of power to line-haul traffic in the two countries and are given in Table 19. When it is borne in mind that a proper com-

TABLE 19

LOCOMOTIVE PERFORMANCE, UNITED STATES AND SOVIET UNION, SELECTED YEARS

	Traffic Units (billion ton-kms. plus billion passenger-kms.)		*Aggregate Tractive Effort (metric tons)*		*Traffic Units per Ton of Tractive Effort*	
	U.S.	USSR	U.S.	USSR	U.S.	USSR
1929	765	145	1,176,800	192,600	63,817	75,285
1938	499	476	986,090	355,400	50,604	133,933
1944	1,332	n.a.	1,053,200	n.a.	126,567	n.a.
1946	1,043	467	1,047,200	425,000[a]	99,599	109,882
1947	1,099	476	1,040,000	440,000[a]	105,673	108,180
1953	n.c.	900	n.c.	551,000	n. c.	163,340

SOURCE: For U.S., underlying data from *Statistics of Railways in the United States* of each year, I.C.C.; for USSR, series C-38 and C-24 in Appendix C.
[a] Estimated.
n.c.=not comparable.

parison would be in gross ton-miles which, in the Soviet data, would be too far removed from statistics in which we can have some confidence, these comparisons indicate the possibility that the Soviet roads have achieved approximately the performance claimed.[54] The data for the two countries should be somewhat closer together in gross-ton-miles, since the ratio of tare to total weight is higher in the United States as a result of the higher percentage of empty car movement and lighter average carload in proportion to light weight of cars. When, in addition, allowance is made for the slower Soviet speeds in both freight and passenger service, the light passenger trainload characteristic of United States operations and the heavier average weight per revenue seat provided, the relatively larger amount of switching work and of light-traffic branch-line service to be performed in the United States, and other factors, even the very high Soviet figure for 1953 loses most of its improbability. U.S. motive power was under greatest pressure in 1944, but even then it is doubtful whether important parts of it

[54] Here it should be remembered that the ton-kilometers employed for computing the Soviet relationship are undoubtedly overstated.

were, in the light of traffic conditions, capable of being usefully employed for as great a part of the average day as is feasible under Soviet conditions, while there was some loss of potential capacity as a result of crew shortage. It must also be recalled that the use of locomotives in American practice is restrained by working agreements with the operating unions which have no counterpart in Soviet practice. The conditions of these agreements in particular occasion the assignment of more switching power than would otherwise be necessary and were not modified even in wartime.

Despite all differences, certain American roads have equaled or exceeded the reported Soviet 1953 performance during years of pressure. This applies notably to the Santa Fe Road, which in 1943 and 1944 recorded approximately 163,000 traffic units per ton of aggregate tractive effort, and to the Union Pacific, which exceeded 173,000 in the same years. The Southern Pacific was not far behind. These and other roads now have a higher level of performance, but as it is achieved almost entirely with diesel power, it cannot be assigned significance in testing Soviet performance, which has been primarily in steam. All three of them, however, operate under more difficult profile conditions than the Soviet system, and even in the war years they endeavored to maintain a superlatively fast passenger and manifest freight service while also handling a large number of special military moves. The three taken together accounted for approximately 12 per cent of the 1944 traffic units of American railways. By way of contrast, the Pennsylvania, which handles more than 10 per cent of the traffic units, with its heavy passenger business, vast local freight business, and relatively short hauls, achieved only 109,000 traffic units per ton of tractive effort in 1944.

FREIGHT CAR EQUIPMENT

A great deal of attention has been focused on the rapid turnaround reported to be achieved by the Soviet freight car stock. When due consideration is accorded the long average haul, it does not immediately appear plausible. The Russian railroads before World War I had a turnaround which, considering the short average haul and the small capacity equipment employed, compared unfavorably with Western Europe and North America.[55] During the late war years and the revolutionary period, conditions appear to have worsened materially and prewar turnaround was not approached again until

[55] For turnaround data, see series C-29.

1925/26. Thereafter a steady decline continued until the early 1930's when the level fluctuated around 9.5 days. Under the pressure of the "transportation crisis," this datum was forced down to 6.78 days in 1936 and thereafter was generally somewhat higher until, during the war period, it advanced to substantially higher levels, attaining an apparent maximum of 13.8 days in 1942. The postwar period has been characterized by a rapid decline to 6.23 days in 1955 and 5.72 days in 1959, the last year for which a report is available. By contrast to these rapid reported car turnarounds for the Soviet system, U.S. railroads have only twice recorded a turnaround of less than fourteen days and in the last few years have encountered turnarounds exceeding fifteen days. Attention has already been called to the longer average hauls prevailing in the Soviet Union, as well as to certain other factors affecting car turnaround. It is necessary to undertake here a more systematic appraisal.

The concepts employed in the two countries are similar but not necessarily the same.[56] Both relate the stock of serviceable cars on line to the cars loaded. The Soviets appear to exclude inactive and light repair cars, however, both of which are included in the United States turnaround as ordinarily computed. Car turnaround is thus a calculated datum whose accuracy depends upon the accuracy of the record of cars on line and of the reporting of cars loaded. In neither country are actual serviceable car-days available, the size of the stock being taken at a given date (reported on the first and fifteenth of the month in United States practice) and applied to the carloadings of a more extended period. Car turnaround differs, of course, not only from year to year, but from month to month. Thus in United States practice, car turnaround reaches its minimum ordinarily in the October peak weeks. The best reported performances for the four highest consecutive weeks calculated from October 1 serviceable cars on line less minimum surpluses appear to have been those of October 1929 and October 1939 at 11.7 and 11.3 days respectively.[57] The 1939 turnaround was exceeded in every year of World War II and, under the influence of the five-day week and other changed conditions, turnaround has assumed a generally higher level in more recent peak periods.

[56] Active, serviceable, or "working" car stock divided by carloadings. Thus the ratio is intended to give elapsed time from one loading to another.

[57] Calculated by the Association of American Railroads and reported to the Office of Defense Mobilization for use of the "Conway" Committee on rolling stock requirements.

Whereas the accuracy of U.S. data for serviceable cars on line can be accepted, the reported surplus is normally understated and tends to vary in accuracy with the supply of and demand for cars. Hence any calculation which seeks comparability with the Soviet concept by employing active cars to compute turnaround tends to overstate United States car turnaround. On the other hand, Soviet records of cars in existence and on line are loose and would appear to be easily subject to manipulation. Our conclusion is that the number of active cars on line, the "working fleet," is understated and that the percentage of understatement varies from time to time and is related to the contemporaneous pressures for a good statistical showing. In short, the figure is manipulated. It appears impossible to develop any measure of the understatement, but the existence of a bias contrary to that of the U.S. data should continually be borne in mind. Nor can the possibility of accretion in the percentage of understatement of the Soviet "working fleet" be discounted completely. An understatement of 10 per cent in the "working fleet," which is far from improbable, would increase a reported turnaround of seven days to 7.8 days. We have no basis for suggesting that the understatement is of this order of magnitude, however, and it could exceed this level.

This is a matter of considerable importance, for it indicates a larger investment in rolling stock than we are led to expect by the published data purporting to show the ownership of freight cars. Moreover, since it means an understatement of car turnaround, confidence that this equipment is understated can diminish our suspicion of the ability of carriers to handle the reported traffic as represented by carloadings.[58] It is desirable, therefore, to review the evidence that leads us to this conclusion.[59] This necessitates some discussion of our understanding of Soviet car accounting for, more than anything else, the looseness in the system of car accounting leads us to expect substantial understatement, and we find this conclusion reinforced in those years for which a check of in and out movement in the fleet with the reported inventory has been possible.[60] It appears that the Soviet statistics of cars available to the railroad service (inventory fleet) rest not on what is in effect a perpetual inventory, as on American railroads, but on physical inventories taken each year with a resulting adjustment of

[58] Our appraisal of ton-kilometrage appears in Chapter 2.

[59] Disparity between growth of the inventory and working fleets and the data upon cars built and retired has been noted in Chapter 2 and is discussed at greater length in Appendix A.

[60] The discussion here, of course, refers to car turnaround computed by dividing the working fleet by average daily carloadings.

the account when particular car numbers fail to appear in the inventory for a prescribed number of consecutive years.[61] Additions to the fleet are not necessarily recorded except as they are picked up through the count, while cars actually in existence and hitherto recorded may be dropped as a result of their failure to be picked up in the count. Moreover, the portion of this stock attributed to the working fleet is subject to manipulation by transfers to bad order, to reserve, to other ministries by lease, to railroad construction, to use for company material and other railroad service, and to the Ministry fleet, among other possibilities.[62] The absence of per diem settlement between the several railroads making up the system leaves a gap in the statistics of car movement and car location because of the failure of car interchange reports to reflect accurately the movement.

To ascertain car stock by a physical count of cars on the line is a method which at best leads to understatement. Cars at outlying sidings and nonagency points are likely to escape the count. Even in yards and in large industrial districts cars are likely to be ignored. On American railroads many instances come to light of serviceable cars which have been allowed to stand idle from failure of notice for extended periods of time sometimes exceeding a year. Such cars have not been reported to the car distributor as available for loading. Many more such instances undoubtedly exist than reach the attention of the supervisors and car service agents of the Association of American Railroads and of the Interstate Commerce Commission. But such cars on an American road are included in the serviceables reported on line and enter the calculation of car turnaround, for the car record office, quite independently of the 7 A.M. or other counts, maintains a perpetual inventory adjusted by installations, retirements, cars delivered to connections, and cars received from connections, which is reduced only by the count of cars reported surplus and in bad order when computing car turnaround.[63] Under the American system there is no incentive actually to fail to detect the existence of serviceable cars, although yardmasters and agents may be tempted to hold

61 At inventory, or "census," time an effort is apparently made to hold railroad operations to a minimum until the census can be completed. Detailed instructions issued for the taking of the census appear designed to secure as much accuracy as possible.

62 It is also unclear whether cars which pass onto trackage of other ministries in connection with industrial switching, loading, and unloading operations are included in the working fleet.

63 Bad-order cars are, however, subject to manipulation—usually to understatement where pressure is exerted to increase the serviceable fleet. Such understatement necessarily increases car turnaround.

It is necessary, if car turnaround is to be understood, to obtain some conception of its composition, that is, to account for the time of the car spent in the various activities between one loading and the next. Soviet students have from time to time undertaken analyses—indeed a good bit of attention has been concentrated on the subject. Less study has been accorded it elsewhere in the world and only one effort has been made in the United States to secure an actual record of the history of the movement of a large number of cars under load—that of the Federal Coordinator who did not, however, study the complete car turnaround. The adoption of machine methods is now leading some U.S. railroads to study the movement of cars on their own lines. For the present, however, we must work with a paucity of material. Table 20 sets out two calculations of turnaround on U.S. railroads made at widely separated times, but the later one is based on the method and on some of the assumptions of the earlier one, together with a breakdown of Soviet car turnaround at several different times, given in days. Except for much heavier proportions of less-than-carload freight than has ever characterized Soviet rail operation, the U.S. performance of 1910 probably comes the closest to Soviet conditions. That of 1954 departs so far from conditions in the Soviet Union as to afford an unsatisfactory basis for comparison. Undoubtedly, the turnaround in peak months was somewhat less than that shown in Loree's 1910 analysis, but we may nevertheless proceed to some comparisons which accept his estimates as a point of departure and employ the Soviet 1940 data as representative, although not the lowest on record.

The differences in the line-haul portion of the account result from a U.S. turnaround trip (loaded plus empty) in 1910 of 571 kilometers compared with a Soviet turnaround in 1940 of 1,032 kilometers, while the U.S. road speed in that year was 16 kilometers compared with 20.3 kilometers for the USSR in 1940. The average U.S. car is assumed to have encountered 5.4 intermediate yardings and interchanges on this average haul; the Soviet car, approximately 10 intermediate yardings over its longer haul. Zagliadimov reports an average delay of 6.5 hours per intermediate yarding, while the Loree estimate supposes 17.9 hours for the U.S. average intermediate yarding or interchange. Neither the Soviet nor the Loree estimates represent an actual accounting for elapsed car time between receipt and dispatch. Interchange between U.S. roads frequently involves a double yarding plus the loss of time on interchange tracks. Thus the U.S. yardings should be increased by 3.6 to obtain greater comparability, resulting cars to protect loading in their own territory and thus fail to report them as surplus to the car distributor. Under the Soviet system, however, a premium is placed upon failure to report the existence and location of cars because of the emphasis on operating norms which derive from the size of the car stock. The presence of underreporting is appreciated and is frequently commented upon with examples that have been discovered in the Soviet railroad press. Hence a system which would in any event tend to understatement would appear to become a worse instrument as a result of the stimulus to increase the downward bias by nonreporting. Moreover, cars accumulated for seasonal loading are specifically excluded from the working fleet. No confidence can be developed in the significance of data developed within such a system nor can any precise interpretation of freight car turnaround be developed in consequence.

Because of the importance attached to the intensive use of cars, however, Soviet railroads use a more direct and more complicated method for securing current information on turnaround. This method builds up the several elements which, when added, give car turnaround in hours. The line-haul portions are determined by using the relationships:

$$\frac{\text{car-axle-kilometers}}{\text{technical speed of trains}} \quad \text{and} \quad \frac{\text{car-axle-kilometers}}{\text{section speed of trains}}$$

The difference between these gives the time spent at way stations. Major intermediate yards compute yard detention *hourly* on the basis of the car count at 6 P.M. plus receipts less dispatchments. Origin and destination stations keep records of each car received or dispatched, showing by car number the time attributable to loading and unloading, separated into operations conducted by the railroad and those conducted by other enterprises, and time spent in yard operations. Detailed instructions are given for the inclusion or exclusion of cars from the working fleet. A disparity, called undistributed time, exists between the aggregate car time accounted for in this manner and the total car time of the working fleet calculated as previously described. This has run in recent years between 2 and 2.5 per cent of total car time compared with 10 per cent in 1940. Since 1952 the unaccounted-for time has been distributed proportionately among the several elements making up the complete car turnaround.[64]

[64] Iakubov, *Osnovy zhelez. statistiki,* pp. 168 ff.

TABLE 20

COMPARISON OF FREIGHT CAR TURNAROUND TIME, UNITED STATES AND SOVIET UNION, BY COMPONENTS
(days)

	United States		*Soviet Union*			
	circa 1910[a]	1954[b]	1934[c]	1935[c]	1940[d]	1958[e]
Road movement (loaded plus empty)	1.49	1.53				
Road delays	0.15	0.19	3.02	2.66	2.11	1.36
Intermediate yards and interchanges	4.03	4.58				
Movement between terminal yard and loading and unloading tracks	1.74	2.10	3.84[f]	3.44[f]	2.90[f]	2.69
Repairing cars and their movement between yard and repair tracks	1.34	1.52	[g]	[g]	[g]	
Surplus cars and movement to and from storage	0.75		[g]	[g]	[g]	
Total responsibility of railway	9.50	9.92	6.86	6.10	5.01	4.05
Loading and unloading	4.00	4.00				
Delay because of bill to order, reconsignment, plant use, etc.	0.50	0.50	1.91	1.61	2.36	
Delay due to Sundays, Saturdays, and 7 holidays per year	0.90	1.22				
Total responsibility of shipper	5.40	5.72	1.91	1.61	2.36	1.77
Total turnaround	14.90	15.64	8.75[h]	7.69[h]	7.37	5.83

a L. F. Loree, *Railroad Freight Transportation*, New York, 1922, pp. 263 f.

b L. K. Sillcox, "Goal: 100 Miles a Day," *Railway Age*, Nov. 28, 1955, p. 31.

c See Appendix A.

d Zagliadimov, *Organizatsiia dvizheniia*, p. 384.

e *Narodnoe khoziaistvo SSSR v 1958* [The USSR National Economy in 1958], Moscow, 1959, p. 556.

f It is possible that movement to and from loading tracks in the Soviet data is included in the figure given below for loading and unloading rather than here.

g Light repair cars, while included in the U.S. serviceable stock, are believed to be excluded from the Soviet "working fleet." Hence this element disappears from Soviet turnaround. The same is true of surplus cars.

h Total does not agree with detail because of rounding.

in an average detention of 10.7 hours. Soviet yard detention at stations with a car turnover exceeding 200 cars daily is computed on the basis of cars on hand each hour, the figure being presumed to remain unchanged until the next hourly count. The car-hours thus determined are divided by one-half the sum of the cars received and dispatched. Cars received and dispatched in solid trains are included in the count. It is probable that a tendency to underreport cars on hand reduces this figure, but some of the differences between Soviet and U.S. detention result from different conditions, e.g., a more even flow of cars through yards over the week, the absence of so large a branch-line network, the absence of a great multiplicity of routings between principal points which compel the longer holding of cars for many classifications, the absence of prior classification as an accepted practice on U.S. railroads in 1910, and the much heavier freight traffic density on the Soviet roads in 1940 than prevailed on U.S. roads in 1910. As it appears that the movement to and from loading tracks of shippers is not included in the Soviet data on detention at intermediate yards and neither the light repair of cars nor the movement and storage of surplus cars is included in Soviet turnaround, we may reduce the duration of the U.S. railroad responsibility of 9.50 days by the sum of these elements, or 3.83 days, giving a figure of 5.67 days to compare with the Soviet 5.01. It will be observed, however, that the Soviet figure had been brought down by almost a day by 1958.

When 1.74 days for movement between terminal yard and loading and unloading tracks is added to the 5.40 days shown as the responsibility of the shipper in the United States, we have 7.14 days for U.S. turnaround to compare with 2.36 days in the Soviet Union. The latter is in effect a residual, and it is understated to the extent that the active car stock is understated, but overstated to the extent that detention at intermediate terminals may have been minimized. The items for delay because of Sundays, holidays, and traders' practices presumably have no counterpart in the Soviet system that is in any respect comparable. If they are deducted we have: United States, 5.74 days; USSR, 2.36 days. These remnants presumably represent in each country the movement of the empty to the point of loading, loading the car, switching the load to train yard of origin, switching the loaded car to the unloading track at destination, unloading the car, and switching out the empty. Not all of these moves are encountered in every car turnaround as cars unloaded at a plant may in both countries be appropriated for outbound loading. This practice may well be more common in the Soviet Union than here because of the lesser diversity of car types, but there should not be any great differences from our 1910 conditions as the bulk of specialized cars are of more recent development.

Although it is believed that the understatement of turnaround is primarily concentrated in the element now under discussion, it is to be observed that the outstanding favorable factor for high car utilization on the Soviet railroads is the enforced cooperation of shippers in the prompt loading and unloading of cars. From what is known under this head, it would appear that instead of four days for loading and unloading in the United States, not more than one day should be allowed in Soviet practice. Hence our residuals come very close together and it would appear that the differences in turnaround can, for the most part, be explained. The available evidence indicates that shipping and receiving divisions of industrial plants are expected to perform loading and unloading operations around the clock seven days a week and to speed up car movement even when other plant sections are closed on Sundays and official holidays. Daily carloading data support this presumption, for the available daily carloading data for 1933 and 1934 do not indicate any significant weekly periodicity.[65] Whereas American shippers have been accorded forty-eight hours free time computed from the first 7 A.M. *after* the car is placed for loading or unloading, Sundays and holidays excluded, and are protected against bunching and against many adverse weather conditions which may affect the unloading of certain types of freight, Soviet shippers are given norms adjusted to the commodity and size of car and expressed in hours. In addition, American shippers generally enjoy an extra twenty-four hours free time for each diversion or reconsignment and in movements that require transfers to water carriers up to seven days free time is commonly provided, sometimes more in the export trades. It appears that, on the average, shippers come close to utilizing the free time available to them. Ordinarily penalty demurrage is not assessed, the standard demurrage rate differing little from the per diem rental rate and being ordinarily insufficient to discourage the holding of cars. Nor are incentives accorded for quicker car handling except as average agreements may permit fast handling of some cars to offset the slow handling of others. Inciden-

[65] A. Iakobi, *Zheleznye dorogi SSSR v tsifrakh* [USSR Railroads in Figures], Moscow, 1935, pp. 114-117. This factor also helps explain the greater average terminal detention of U.S. railroads, for a marked reduction in car dispatchments normally occurs on Sundays and holidays and certain classifications cannot be dispatched in the absence of train service.

tally, the demurrage tariff does not apply to cars loaded at coal mines where the holding of no-bills[66] sometimes goes to extremes.

The established Soviet norms for the loading and unloading of cars by shippers are given by Popatov as they apply to nonmechanized operations.[67] They are differentiated by commodity and by type of car. They range from one hour for piece goods in cars with a capacity of under forty tons to five hours for glass, bottles, etc., in cars with a capacity of over forty tons. Fines are collected by the railroads for the detention of cars beyond the established norms while premiums are paid to shippers and receivers of freight for accelerated loading and unloading of equipment.[68] It appears, however, that loading and unloading norms are, from time to time, adjusted and that shipping ministries can, on occasion, bring effective pressure to bear to secure more liberal norms. Moreover, in recent years certain ministries, notably those for coal, metals, lumber, construction materials, have tended to fail to meet the norms and hence have come in for a good deal of criticism.[69] Apparently the railroads have not been without fault, for Beshchev, calling attention to the fact that detention in loading and unloading has been slow in decreasing and stood in 1953 at 2.3 hours above 1940, criticized railway managements for increasing norms without cause.[70] The action of the Tomsk Railroad in raising the norm for the Kuznetsk Metallurgical Combine from 9.5 hours in 1950 to 17.7 hours in 1953 is cited with marked disapproval. The decline in 1953 in what is referred to as "idle time" at shippers' sidings was only 0.7 hours, according to Beshchev, and total turnaround time was short of the goal by approximately one hour. Shippers were called upon to deliver loaded cars more evenly throughout the hours of the day. The decided difference in relationships between shipper and carrier in the Soviet Union, compared with the United States, is adequately discussed elsewhere and need not be dealt with further here.[71] That it has a significant favorable effect upon car turnaround cannot be doubted.

In considering the over-all effects of the rapid car handling that appears to be enforced, it is well to observe that a rapid car turn-

[66] No-bills are cars loaded prior to preparation of bill of lading, often because the contents have not been sold and the destination is, therefore, unknown.

[67] V. P. Popatov and A. T. Deribas, *Kommercheskaia ekspIoatatsiia zheleznykh dorog SSSR* [Commercial Operation of USSR Railroads], Moscow, 1950, Appendix 4, p. 399.

[68] *Ibid.*, p. 111.

[69] L. M. Kaganovich, in *Pravda*, May 24, 1954, p. 3.

[70] B. P. Beshchev, then Minister of Transport, in *Pravda*, May 19, 1954, p. 2.

[71] Hunter, *Soviet Transportation*, pp. 128-130.

around is secured in considerable part by higher proportionate inputs—in all likelihood, primarily labor inputs—by shipping and receiving installations. Scant evidence has come to our attention concerning facilities or methods used by Soviet industrial plants, but the impression created is of the use of overwhelming quantities of ordinary labor. A larger portion of freight, perhaps 40 per cent of the total, moreover, moves through railroad-operated freight stations and is thus loaded and unloaded by railroad forces.[72]

Certain Measures of Efficiency

Despite important misrepresentations in the Soviet statistics, it is apparent that an intensive utilization of permanent way, terminals, motive power, and equipment is secured. This is achieved, in part, at the expense of heavy inputs of other resources. Although only a fragmentary picture can be constructed of these other inputs which affect the efficiency of operations, some insight can be secured from the data developed in connection with this study. Serious difficulties of interpretation and comparison, however, confront the student.

FUEL

A major input in railroad transportation is fuel which, in the Soviet case, is still almost entirely coal.[73] It is customary to measure the consumption in pounds per thousand gross ton-miles or other such units. Such a measure is reported for the Soviet railroads, but it is quite obviously not computed on the same basis as for U.S. railroads and does not, therefore, afford a direct basis of comparison. The Soviet data, presumably applying to all classes of freight and passenger service, in kilograms per 10,000 gross ton-kilometers are given in Table 21. U.S. data are given in pounds of coal per thousand gross ton-miles for freight service only. In earlier years passenger service fuel consumption was reported on a ton-mile basis. There are important differences in the methods of reporting data, however. The Soviet data equate all fuel to a 7,000-calorie per kilogram standard, whereas the U.S. data are based on actual tons consumed but equate oil fuel and electricity on a calorie basis to the average characteristics

72 By contrast, over 90 per cent of freight in the United States other than that transshipped to or from water moves between industrial sidings and, of the remainder, the greatest part is loaded and unloaded by shippers and receivers.

73 Fuel approximates 18 per cent of transportation expenses of Class I railroads of the United States and approximately 32 per cent of all purchases of supplies and materials.

TABLE 21

LOCOMOTIVE FUEL CONSUMPTION, SOVIET RAILROADS, 1928-40 AND 1945-59

(kgs. of 7,000-calorie units per 10,000 gross ton-kms in freight, passenger, and yard work)

	All Locomotives	Steam Alone
1928	201	301
1929	292	292
1930		
1931		
1932	282	282
1933	288	288
1934	262	262
1935	252	252
1936		
1937	269	269
1938		
1939	249	249
1940	248	248
1945	281	
1946	286	
1947	291	
1948	254	257
1949	232	236
1950	221	225
1951	212	217
1952	206	211
1953	199	205
1954	195	201
1955	185	194
1956	184	196
1957	171	183
1958	163	179
1959	156	180

SOURCE: 1928, 1932, 1937, 1940, 1950-58: Iakubov, *Osnovy zhelez. statistiki,* p. 248; 1929, 1933-35: *Sotsialisticheskoe stroitel'stvo SSSR* [Socialist Construction in the USSR], Moscow, 1936, p. 435; 1939, 1945-57: Hunter, *Soviet Transportation,* p. 307; 1948-49: *Tekhnicheskii spravochnik zheleznodorozhnika* [A Technical Handbook for Railway Men], Moscow, 1955, Vol. II, p. 243, where the figures are displaced by one year; 1959: *Zheleznodorozhnyi transport* [Railroad Transportation], 1960, No. 3, p. 35.

of coal burned on each individual railroad. They are not, therefore, designed to be comparable between railroads, and the average consumption for the system cannot be referred to a specific quality of coal. Finally, the Russian data are roughly 65 per cent of actual consumption, this adjustment being made in recognition of "the coefficient of useful action of the steam boiler. . . ."[74]

[74] T. S. Khachaturov, *Ekonomika transporta* [The Economics of Transportation], Moscow, 1959, pp. 214-215.

The U.S. data for a selection of years prior to extensive dieselization, and for freight service, Class I railroads, are:

Pounds of Coal per 1,000 Gross Ton-Miles[75]

1936	119	1945	116
1938	115	1946	116
1940	112	1947	114
1942	111	1948	111

It would be illustrative to convert the Soviet data into pounds per thousand gross ton-miles, but, as indicated, no direct comparisons can be made because of the difference in the method of computing the average and because the Soviet figure includes the passenger service. The best Soviet prewar performance was in 1940, which was the equivalent of 123.4 pounds per thousand gross ton-miles. This was a substantial improvement over 1929 when the figure stood at 145 pounds. Postwar consumption was higher for a few years, reaching a peak of 144.7 pounds in 1947. Since then improvement has been steady and the figure, for steam locomotives only, reached 101.5 pounds in 1953. Substantial modernization of Soviet steam power in recent years no doubt contributed to the sharp reduction in consumption in the period since 1947, as did the retirement of older power and replacement with new. Great emphasis has also been placed upon fuel economy. Yet it seems impossible fully to explain so great an improvement.

For 1940, however, we may approach the problem in another way. The transport industries are reported to have consumed 49.5 million tons of coal in that year, or 30.0 per cent of total coal consumption for all purposes.[76] The exact coverage of this consumption is not wholly clear, but information on the use of other fuels has a bearing on it. Little wood appears to have been used for locomotive fuel in 1940. In 1942 some conversion to wood firing is reported on the Northern Railway and apparently in scattered fashion elsewhere. Wood reached 11.5 per cent of total consumption in 1943, but by 1946 was down to 0.3 per cent. Petroleum fell from 8.1 per cent in 1940 to 6.8 per cent in 1943 and to 2.6 per cent in 1946. Brown coal, however, increased from 6.3 per cent in 1940 to 17.02 per cent in 1943 and 21.6 per cent in 1946. It is not clear whether the figure given for 1940 transport consumption includes or excludes brown coal.[77]

[75] *Statistics of Railways in the United States,* 1946 and 1948, I.C.C., Table 60.

[76] N. A. Voznesenskii, *Voennaia ekonomika SSSR v period otechestvennoi voiny* [Soviet War Economy During World War II], Moscow, 1948, p. 69.

[77] Comparability with U.S. data is, therefore, in doubt. The U.S. data include lignites.

We may reduce Soviet consumption by 10 per cent to eliminate consumption by transport other than rail. We may reduce gross ton-kilometers by 8 per cent to eliminate those produced by use of petroleum fuel and by 10 per cent for those produced by electric power. Gross ton-kilometers must, however, be estimated. At Soviet load factors and equipment weights, passenger-kilometers come close to measuring gross ton-kilometers in passenger train service. Freight car-kilometers can be estimated from average kilometers per car-day and from the number of cars reported in the working fleet. An average weight per two-axle unit can be assumed. The resulting data may be converted into ton-miles. Thus we have 486.1 billion gross ton-miles produced by coal-burning steam locomotives with a consumption of 44.7 million metric tons of coal, or 49.17 million short tons. In 1940, 96 per cent of U.S. gross ton-miles, or 1,134.6 billion, were produced by steam power with a consumption of 96.1 million equivalent tons of coal.[78] Thus we have 9.9 billion gross ton-miles produced on the Soviet railroads for each million tons of coal, compared with 11.8 billion ton-miles per million tons of coal on U.S. railroads in that year. Such a comparison is by no means conclusive, involving as it does a number of estimates and adjustments as well as some doubt about the comparability of the basic data. From the known characteristics of Soviet steam power, however, it would appear certain that consumption would be heavier per thousand gross ton-miles on equivalent profile than for the more modern and complicated power prevalent in the United States in 1940. On the whole, Soviet profile appears to be more favorable than is the case on American roads, which would suggest that, with power of equivalent thermal efficiency similarly maintained, with similar quality of coal, and with equally efficient firing, Soviet consumption should be less than United States consumption per thousand gross ton-miles. These equivalences quite clearly did not exist and heavier consumption results.

LABOR

There appears to be no doubt that employment on the Soviet railroads far exceeds our own and that productivity per worker, as measured in composite freight and passenger ton-miles per worker, is much lower. No sharply defined conclusions should be drawn from the

[78] Oil burned in steam power was converted into coal equivalents in accordance with I.C.C. reporting requirements on the basis described earlier. These equivalents for individual railroads are given in *Statistics of Railways in the United States*, I.C.C., 1946, Table 73.

data as the coverage of the Soviet operating labor force is not fully understood while our own employment by steam railroads has been affected from time to time by the amount and character of work placed with outside firms, by fluctuations in the amount of construction, and by the degree to which such construction has been contracted for rather than performed by the carriers' own forces. Much such work is mixed in character. Not since 1929, however, have American railroads (including the Pullman Company and express companies) had as high an employment as the Soviet railroads have shown in each of the last three years.

Data on the Soviet railway labor force are given in series C-39 and C-40 in Appendix C. It will be observed that series C-40, which gives estimates of the operating labor force, is occasionally derived from the productivity data of series C-39 and the composite traffic data of series C-38. It will also be noticed that, during a part of the period, it has been possible to compute a more inclusive series which also embraces the employees in the work train service. The bulk of new railroad construction is performed by other organizations whose employees are not included here. Undoubtedly, however, much work train service is operated in support of such construction.

The precise content of the railway operating labor force is difficult to determine from the available data, and a reconciliation of its composition with that of U.S. railroads calls for considerable speculation. The distribution by "railroad management branches" is given for 1950 as follows:[79]

	Per Cent
Locomotive service	23.6
Track maintenance	22.3
Traffic management	17.6
Freight car service	11.0
Passenger service	6.8
Signaling and communications service	4.2
Commercial service	2.6
Building and installation maintenance	0.8
Railroad division and administrative agencies	4.0
Other	7.1
Total	100.0

The classification differs fundamentally from that employed in the United States since it mixes transportation and maintenance functions and thus makes direct comparisons impossible. Were the full detail of the Soviet labor force known in a breakdown similar to

[79] I. V. Kochetov, *Zheleznodorozhnaia statistika* [Railroad Statistics], 2nd ed., Moscow, 1953, pp. 156 ff.

that of the United States by type of position, a more effective analysis could be undertaken. Some immediate differences both in coverage and function are, however, obvious. Some components of the Soviet work force are absent in the American system, e.g., political agencies and other organizations which account for 4.5 per cent of the Soviet railroad force. The identifiable administrative echelons of the Soviet system are at much lower strength than in the American system. The traffic departments of American railroads—rates, sales, advertising, and industrial development—have but a feeble counterpart. The personnel required for certain functions, e.g., heavy locomotive and car repair and new line construction, are included in the Ministry staffs, as are the personnel charged with the primary budget functions, whereas in the United States these are included in the employment of the railways.[80] As the majority of timber-treating plants are operated independently or by subsidiaries in the United States, their inclusion in Ministry forces does not appear to add another element of incomparability. A primary obstacle to understanding the composition of the Soviet railway force is, however, the difference in the reporting of personnel by the primary functions of railway operation, which at least suggests a difference in organization concepts.[81] In attempting

TABLE 22

DISTRIBUTION OF RAILROAD LABOR FORCE IN UNITED STATES AND SOVIET UNION, 1950
(per cent)

United States		Soviet Union	
Transportation			
Train and engine service	20.9	Locomotive service	23.6
Yard forces	1.3	Traffic management	17.6
Other	11.6	Freight car service	11.0
		Passenger car service	6.8
Maintenance of equipment	28.2		
Total	62.0	Total	59.0
Maintenance of way	19.7	Maintenance of way (incl. signals, buildings, and electrification)	28.0
Professional, clerical, general	18.3	Other	13.0
Total	100.0	Total	100.0

SOURCE: For U.S., *Statistics of Railways in the United States*, I.C.C., 1950; for USSR, see text above.

80 I. V. Kochetov, *Zheleznodorozhnaia statistika* [Railroad statistics], 1st ed., Moscow, 1948, p. 163.

81 It would appear, for example, that the locomotive department more nearly parallels British than American practice, embracing not only the shop and engine house forces but the engine crews as well.

to compare the Soviet with the U.S. distribution of workers, we must effect combinations that deprive the totals even of certain principal breakdowns commonly employed in summary employment statistics, for we must combine transportation and maintenance of equipment categories (see Table 22). Maintenance of equipment is underrepresented in this comparison since the heavy repair forces are under the Ministry. Such forces are the equivalent of 8.8 per cent of the railway operating staff and their addition would bring the transportation and maintenance of equipment forces to a percentage slightly above that for the United States. So far as appears from these data—and the evidence is highly inconclusive—the principal difference in composition of the Soviet working force in the major departments of operation is the much larger proportion of the force devoted to maintenance of way. This is to be expected in view of the limited degree of mechanization of trackwork in the Soviet system.[82]

What little evidence there is suggests that the operating labor force as reported for the Soviet railways is somewhat less inclusive than that reported by railways of the United States.[83] Other differences that affect productivity calculations concern the count of workers upon which the force is based. The U.S. data represent the averages of twelve midmonth counts. The Soviet data employed for the productivity calculations appear to be developed from actual hours worked adjusted to standard per worker expectancy. There is the possibility that a difference in concept results, therefore, in a relative overstatement of workers employed on the U.S. railways. We are not in possession of man-hours worked on the Soviet railways, hence we cannot progress to hourly productivity data which would be far more useful than those which we possess. Nevertheless we may acquire some notion of the relative inputs of labor if we relate the available data to the traffic data. As we do so, we should bear in mind the upward bias of Soviet traffic data and the probable downward bias of employment data. If, therefore, we find a larger labor input per traffic unit in the Soviet Union, we shall have understated the difference.

Because of differences in the quality of service, both freight and passenger, it would be desirable to develop measures of the volume

[82] By contrast, mechanization of trackwork for new construction appears to have been carried rather far along lines similar to British railways.

[83] As the categories which account for the overwhelming proportion of operating and maintenance workers are contained in the series of both countries, this is not a bar to securing some general understanding of the relative use of labor.

of service produced weighted by value. This we are unable to do and must confine ourselves to the employment of ton-mile data. As observed elsewhere, the Soviet composite traffic series is a simple addition of ton- and passenger-kilometers, which is a reasonable meshing of the series to represent probable gross ton-kilometers in the two services. Passenger service in the United States is, however, of a different order and is operated according to entirely different standards for speed, weight of equipment per seat, passenger load factor, non-revenue space, and other matters. While there are certainly differences in the quality of freight service, notably in train speed, these differences are smaller than in the passenger service. In comparing the two systems to secure some approximation of labor productivity, we would be fully justified in assigning greater weight to passenger-miles in the United States series. The disparity, however, turns out to be so great that no considerable speculation on this point is useful. The data are developed in Table 23.

TABLE 23

COMPARISON OF LABOR PRODUCTIVITY IN UNITED STATES AND SOVIET UNION, SELECTED YEARS

	United States[a]			*Soviet Union*[b]
	Composite Metric Ton-Kilometers[c] (billions)	Employees[d] (thousands)	Ton-Kilometers per Employee (thousands)	Operating Ton-Kilometers per Employee (thousands)
1930	661.1	1,517	435.8	204.4
1932	404.1	1,052	384.1	247.4
1934	462.0	1,027	449.8	251.6
1936	584.1	1,086	537.9	336.9
1938	499.2	958	521.1	358.8
1940	635.4	1,046	607.5	380.6
1945	1,215.2	1,439	844.5	273.9
1949	879.0	1,207	728.2	373.4
1950	762.5	1,236	778.7	409.9
1953	981.6	1,221	803.9	488.7
1954	890.4	1,079	825.2	506.6
1956	1,025.6	1,123	913.3	622.4
1958	889.1	908	979.2	737.8

a From *Statistics of Railways in the United States*, I.C.C., of each year.

b Series C-39, col. 2, in Appendix C.

c Net ton-miles converted to metric ton-kilometers plus passenger-kilometers.

d All line-haul railroads. Excludes switching and terminal companies, Pullman Company, and express companies.

It will be observed that a substantial drop in productivity occurred in the Soviet system during the war and that, although the position improved with some rapidity, it was not until a year after the prewar traffic level had been passed that prewar labor productivity was attained and passed. In the U.S. system it will be observed that the wartime level of 1945 was not again attained until after 1954, despite the extensive mechanization of trackwork and wholesale dieselization. Declining traffic is unfavorable to high labor productivity. Moreover, a fundamental shift was produced by the adoption of the forty-hour week for various classes of employees in 1947-50. That Soviet railroads since 1950 appear to have exceeded the U.S. level of 1930 must be regarded as a creditable performance in the light of the tools with which they have to work. An argument can be made, however, that as late as 1954 Soviet productivity had not attained our 1930 level, if proper allowance could be made for the bias of the Soviet data and for the differences in the quality of service rendered by the two systems. Improvement has continued and the 1958 record was as good as the best U.S. prewar performance. Soviet productivity should continue to increase as maintenance-of-way workers are better provided with equipment and as dieselization progresses. The latter should not only permit increased train loading and more rapid yard work, but also a reduction in the size of train crews and the elimination of second engine crews when double-heading is resorted to, except where mixed equipment requires the second engine to be cut into the middle of the train. The margin between U.S. and Soviet productivity has obviously been narrowing, and this trend may be expected to continue with dieselization of the Soviet system. As the next section suggests, the Soviet railways appear to be securing far more salutary results from diseselization than U.S. railroads have achieved.

Effects of Partial Dieselization

The comparisons in this chapter thus far have been confined largely to the Soviet experience before 1954 when more than 90 per cent of the freight working was carried out by steam traction. The U.S. data employed for comparison have generally not been later than 1944 when more than 94 per cent of U.S. road freight service was still accomplished behind steam locomotives. The substantial transition of power in both countries, although it is very recent in the Soviet Union, makes possible some appraisal of the effects of the shift in the two countries. Such an appraisal is subject to many qualifications, the most serious of which are:

1. Soviet freight traffic has been increasing rapidly during the period of transition whereas that of U.S. railroads has exhibited a generally declining trend which has been punctuated by a number of years of depressed traffic volume, and the year during which U.S. roads neared the Soviet 1960 percentage of steam working was a badly depressed year.

2. Soviet steam power at the time the transition began was generally of less modern design, smaller average unit capacity, and lower efficiency than that in service on U.S. railroads at the beginning of the transition.

These differences in part explain the greater improvement in the Soviet performance which has occurred, but it is questionable whether they do so completely. The comparative periods of transition are shown in Table 24. Thus it will appear that, broadly speaking, U.S. railroads moved from 90 to 60 per cent steam between 1945 and 1950 while the USSR moved from 90 to 60 per cent steam between 1954 and 1960.

TABLE 24

PERCENTAGE OF TOTAL GROSS FREIGHT TON-KILOMETERS PERFORMED BY STEAM TRACTION, U.S. AND SOVIET RAILROADS

	U.S. Railroads		Soviet Railroads
1944	94.6	1954	89.8
1945	91.1	1955	85.9
1946	88.2	1956	82.8
1947	85.6	1957	79.4
1948	76.7	1958	73.5
1949	63.1	1959	66.5
1950	53.9	1960	58.5
1951	45.5	1961	

SOURCE: For U.S., derived from detailed figures in *Railroad Transportation: A Statistical Record, 1921-1955*, Washington, 1956, p. 26. For Soviet Union, S. K. Danilov (ed.), *Ekonomika transporta* [Economics of Transportation], Moscow, 1956, p. 327; *Vestnik statistiki* [Bulletin of Statistics], 1959, No. 4, p. 92; *Zheleznodorozhnyi transport* [Railroad Transportation], 1957, No. 3, p. 31, and 1960, No. 3, p. 34. The 1960 estimate assumes an eight-point drop, following a seven-point drop in 1959 and a six-point drop in 1958.

It will be instructive to compare the behavior of certain operating statistics during the respective transition periods. This is done in Table 25 for measures which one would expect to be particularly affected in a favorable direction by the increasing use of diesel power.

TABLE 25

COMPARISON OF RAILROAD OPERATING STATISTICS, UNITED STATES AND SOVIET UNION

United States		Soviet Union	
AVERAGE LOCOMOTIVE-MILES PER LOCOMOTIVE-DAY			
1945	118.4	1954	257
1949	112.5	1959	345
Absolute change	−5.9	Absolute change	+88
		Per cent increase	34
AVERAGE GROSS TRAIN LOAD (TONS)			
1945	2,386	1954	1,660
1949	2,534	1959	2,037
Absolute change	+148	Absolute change	+377
Per cent increase	6.2	Per cent increase	22.7
AVERAGE FREIGHT TRAIN SPEED			
(m.p.h.)		(km.p.h.)	
1945	15.7	1954	22.9
1949	16.9	1959	27.2
Absolute change	+1.2	Absolute change	+4.3
Per cent increase	7.9	Per cent increase	18.9
GROSS TON-MILES (OR KILOMETERS) PER TRAIN-HOUR[a]			
(miles)		(kilometers)	
1945	36,954	1954	38,010
1949	42,346	1959	55,400
Absolute change	+5,392	Absolute change	+17,390
Per cent increase	14.6	Per cent increase	45.7

[a] Gross ton-kilometers per freight train-hour are given by Holland Hunter in *Comparisons of the United States and Soviet Economies,* Joint Economic Committee, Congress of the United States, Washington, 1959, p. 197; *Hearings, November 13-20, 1959,* Joint Economic Committee, Washington, 1960, p. 91.

It will be observed that the improvement in these indexes for U.S. roads was very modest compared with the achievement recorded in the Soviet Union. U.S. freight traffic measured in ton-miles fell by 23 per cent from 1945 to 1949. On the other hand, Soviet freight traffic grew by 67 per cent. In the USSR all elements of plant were being used more intensively and steam power was being augmented and improved even while diesel power came on the road in increasing quantities. In the United States the terminal year of the comparison was marked not only by a poor level of business, but also by strikes which had far-reaching effects upon the movement of traffic. When all of these things are allowed for, however, the Soviet performance appears very good indeed. And even if 1950 U.S. data are used, carrying a little further into the dieselization movement, the U.S. performance is not notably better.

It is probable that train loading and movement in the Soviet Union has also been favorably influenced by significant improvement in the permanent way and signaling. Very little information has come to hand on these points. Condition of track is, in any event, difficult to measure and express. Yet improvement in line and surface permits both increased speed and train loads. And the improvement in signaling and more abundant provision of auxiliary trackage (passing sidings, crossovers, etc.) may materially improve the rate of movement over the road. Some scattered evidence suggests substantial improvement in track. Thus 72 per cent of all main track is said to have had rail weighing at least 43.6 kilograms per running meter in 1958,[84] compared with 56 per cent in 1954 and 17.2 per cent in 1940.[85] By 1957 over 20 per cent of track was laid on crushed stone ballast, while crushed stone and gravel ballast together accounted for 40 per cent.[86] In 1954 some 37.4 per cent was on stone or gravel compared with 24.4 per cent in 1940.[87] Hence a great improvement in the mileage laid with heavy rail has been effected along with some improvement in ballast. Both these developments should have resulted in improved track conditions.

[84] Khachaturov, *Ekonomika transporta,* p. 445.
[85] Danilov, *Ekonomika transporta,* p. 363.
[86] Khachaturov, *Ekonomika transporta,* p. 445.
[87] Danilov, *Ekonomika transporta,* p. 363.