

THE MATERIAL RESOURCES OF THE U. S. S. R.
AND THE SOVIET SATELLITES

17 October 1957

CONTENTS

| | <u>Page</u> |
|--|-------------|
| INTRODUCTION--Dr. M. S. Reichley, Senior Educational Adviser, Industrial College of the Armed Forces | 1 |
| SPEAKER--Dr. Demitri B. Shimkin, Bureau of the Census Department of Commerce | 1 |
| GENERAL DISCUSSION | 13 |

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DR. REICHLEY: General Hollis, Gentlemen: To date in our studies of natural resources we have pretty well confined ourselves to going over the position of the United States and the free world. I think we would be delinquent if we didn't turn to the resource position of the Soviet Union to find out what our potential enemy has in this regard. Consequently, our lecture this morning will cover the material resources of the Soviet Union.

We have asked Dr. Demitri B. Shimkin, of the Department of Commerce, to handle this subject for us. From perusing his biography you will recall that he is a student, a scholar, a consultant, and a writer in this area. His book, Minerals, a Key to Soviet Power, is one of the outstanding ones on this subject. He may have some reservations to mention about it later, but it is a wonderful book; and I commend it to your attention.

Demitri, it gives me great pleasure to welcome you back here to the College.

Dr. Shimkin.

DR. SHIMKIN: General Hollis, Gentlemen: It's always a great pleasure to be back here. This is one of the homes that I have frequented over the last 10 years or more. It is a place where such words as "logistics" and the tough aspects of strategic considerations are always met as challenges rather than as headaches. The talk this morning will deal with a tough subject.

The economy of the Soviet Union, more than that of any other great power in modern times, exhibits a paradoxical combination of formidable strengths and acute weaknesses. Thirty years of concentration upon maximizing Soviet military capabilities have produced a stratified, compartmented socioeconomic system capable of effective military design and production. The system has also been capable of repeated innovation in both science and weapons, the latter notably including the first airborne troops, in 1936; the finest tanks of World War II; and now, giant missiles. But to achieve these capabilities the Soviet Union has

had to weaken other sectors, especially consumers' goods production. Furthermore, the imperious nature of Soviet priorities has promoted disregard of economic balance and of marginal utility, with waste through lavishness in favored areas and waste through extreme inefficiency in those deprived, as results.

The focus of my talk is on the less efficient sectors of the Soviet economy, those producing raw materials for consumption and for industrial use. In general, the picture you shall see compares unfavorably with American achievements. It represents, overall, a significant drag upon other elements of the economy, ordnance included. It demonstrates that Soviet military capacity specifically, rather than some generic economic superiority, is the threat faced by the West today.

Given this framework, my approach to an assessment of Soviet resource patterns and management will be twofold. First, I shall summarize the broad features of Soviet agriculture, forestry, water management, and mining. Second, I will examine in some detail the operating characteristics of the Soviet fuel industries, in comparison with those of the United States. In this way I hope to present to you a ramified set of problems, to give you some measure of their complexity, and to indicate to you some guides toward their solution.

What are the general features of the Soviet resources position?

1. Soviet natural endowment is broadly comparable in magnitude, though neither in quality nor accessibility, with that of the United States.

2. In agriculture, Soviet standard land resources are about 70 percent those of the United States, largely distributed in a great triangle from Leningrad to Irkutsk to the Black Sea. The Soviet agricultural potential, severely limited by cold and dryness, is most suitable for the production of hardy grains and livestock. The areas where other crops--cotton, sugar beets, tobacco, citrus fruits, oil-bearing plants--can grow are very restricted; for example, the 5,000 square miles of the Fergana Valley, in central Asia, which is comparable climatically to central and northern Utah, are the source of two-thirds of Soviet cotton.

Soviet agriculture, like that of Western Europe a century ago, has substantial promise, particularly in the warmer and wetter areas of European Russia. There is no inherent reason why, with modern technology, the Soviet Union should not be able to develop a very firm base

for both grain production and livestock, though the problems from the standpoint of specialty crops are more difficult. But to develop these resources firmly requires a long-time, balanced effort in irrigation, drainage, reforestation, herd improvement, liming, and so forth. This the Soviets, while starting to do from time to time, have never carried out. They have preferred instead cheaper, far more risky, and impermanent expedients like the so-called New Lands Program. Soviet agriculture has also been dominated by Communist Party political needs to gain firm control over the peasant, and by the use of agriculture as a source of human and capital resources for industrialization and armaments.

Through the operation of these factors the U. S. S. R. has developed a system of hyperextensive State farming coexistent with private gardening on a tiny scale. The former produces the vast bulk of Soviet field crops; the latter, nearly half the animal products.

In comparison with the United States, Soviet agricultural output, on 30 percent more acreage, is half as great. It is structurally very different--seven times as much potato output, twice the wheat output, of the United States; but 80 percent of the sugar, 30 percent of the vegetable oil, and half the natural fiber production. Soviet output of animal products, the source of two-thirds of U. S. net farm income, was a fifth of ours in 1955, slightly higher in 1956, and will again decline in 1957, which promises to be an indifferent crop year.

Soviet agriculture is far less mechanized than either the agriculture of this country or the agriculture of most of Europe. The availability of tractor power is only 15 percent as high as in the United States. Truck capacity is only 11 percent as high, while the availability of electric power is 12 percent as great. Incentives are low; restrictions are harsh. It is little wonder, therefore, that with these conditions, and with the low quality of the labor force in agriculture, an enormous input is needed. At the present time over 47 million persons are in Soviet agriculture. But two-thirds of them are women, children, and old people, with men of 16 to 60 comprising only one-third. Furthermore, 80 percent of the agricultural labor force (compared to 50 percent of the nonagricultural) has less than five years of schooling; in other words, is semiliterate at best. As a result, the productivity of labor in Soviet agriculture is astoundingly low--only seven percent that of the United States and far lower than that of any European country, certainly outside the Communist bloc.

3. Soviet forests, almost all softwood, cover nearly two million square miles--three times the area of American forests excluding Alaska. A short growing season, limited moisture, and to varying degrees in many regions, permanently frozen ground, lower natural reproductive rates. Also, the proportion of commercially accessible forest land is low. As a result, the capacity for sustained lumber production in the U. S. S. R. is actually lower than in this country, where the southeastern United States, particularly, is characterized by the extraordinarily high reproductive rate of six percent per year.

In much of European Russia, forest lands have been markedly depleted, so that future plans are oriented toward increasing output from Siberia--an area characterized by very difficult transportation toward consuming centers. This fact is of particular importance to the consumer economy, because fuel wood is to this day the fundamental source of energy for Soviet householders; as a result, the depletion of fuel wood resources has had an adverse effect upon living standards.

Dispersed resources, limited mechanization, difficult transport problems, and a long tradition of forced labor have led to low productivity in Soviet logging, which today employs over two million persons, 10 times as much as in the United States for about the same level of overall output.

The Soviet output of building timber considerably surpasses that of the United States. In fact, timber is used very widely where we use steel frame construction, or various types of synthetic materials, such as fiber board. But the output of more highly fabricated wood products, such as plywood, cellulose, and paper, is very much smaller than our own.

4. Soviet water resources are large and little developed. The present program of water development is largely oriented toward power, with an increasing proportion of high-level dams rather than cascade construction. The output of hydroelectric power is maximized, and the necessity for standby thermal power is reduced, through the development of large reservoirs and a maximum uniformity of discharge at all times of the year; this also leaves little margin for irrigation or flood control.

In hydroelectric construction, actual achievements to date have been rather limited; and Soviet hydroelectric power furnishes somewhat less

than 14 percent of all of the power generated in the Soviet Union. However, certain projects which are to be completed a good many years from now, such as the Angara-Lake Baykal system, are very large and promise spectacular results if they are completed. The most important project, practically speaking, is that centering on the Volga. A large part of this has been completed, including the large Kuybyshev Dam, while the Stalingrad Dam is well under way. This Volga project is beginning to generate a substantial proportion of its planned capacity. The very ambitious high-tension wire, 400 kilo-volts, from Kuybyshev to Moscow, was finally put into operation last year. But other aspects of the project--waterway development and irrigation--have had much less success.

Waterway operation has been indifferently effective because of the paucity of warehouses and other facilities to take care of the seasonal icing problem, which is acute from the end of December through April. Irrigation, a very large feature of the initial plan, is virtually nonexistent. Thus the project has resulted in a net loss of valuable bottom land through flooding, with little substitution of new land through irrigation.

5. Soviet mineral resources are comparable in general to those of the United States. They are very strong geologically in fuels and ferrous metals, weaker in nonferrous. There are some acute deficiencies, particularly in bauxite and in uranium. These are in large part supplied by the satellites. However, the Soviet Union does require imports from the free world for a satisfactory balance in a number of commodities, one of the most important being copper. This the West is supplying, to the tune of more than 15 percent of the copper consumption of the entire Communist bloc. Copper wire constitutes, I regret to say, two-thirds of the exports of the United Kingdom to the Soviet Union.

The development of mineral resources in the Soviet Union represents fundamentally not a geological but an economic problem. The Soviet Union, through the expenditure of vast capital and human resources, has been able to increase its mineral production between 1937 and 1956 3.3-fold, in comparison to an American expansion over the same period of about 85 percent. The American expansion, however, because of the much greater initial base, was 80 percent greater in absolute terms, as opposed to relative, than the Soviet. In addition, as we will see further on, the American expansion has been accompanied by reductions of cost, while the Soviet expansion has been an extremely costly affair.

Let us now turn to a more detailed discussion of the Soviet fuel industry, with particular reference to coal mining and petroleum.

The coal and lignite resources of the Soviet Union are second only to those of the United States, with at least a trillion tons of reserves. Ninety percent of those reserves are concentrated in the area to the east of 60 degrees; in other words, in the Asiatic part of the Soviet Union. The greatest accessible deposit is in western Siberia in the Kuznetsk Basin, with other important resources in Kazakhstan, in eastern Siberia, and in the Far East. A relatively small amount is found in central Asia, in the Donets Basin of the Ukraine, and in north Russia. I say "relatively" because actually even the Donets Basin numbers enough billion tons of reserve to be a reliable base of fuel for many years to come. The only important areas where the quantity of coal is really a major limiting factor are in central and northwest Russia, on the one hand, and in the Urals, on the other.

In the Donets Basin the exploitation of resources has been prolonged, and the available producing mines tend to be deep, with fairly narrow seams. In addition, the coal of the Donets Basin is primarily anthracite. The available coking grades are characterized by very high sulphur content, which is chemically combined, hence difficult to remove. As a result, the Soviet Union, particularly in its primary Ukrainian metallurgical centers (which still produce over a third of all Soviet pig iron) has a serious quality problem. For sulphur is a major element in the production of fractures and other undesirable properties in pig iron. Today, the Donets Basin provides 36 percent of total Soviet coal and lignite output. European Russia, including the Urals, provides 58 percent. The other major basins are the Kuznetsk, which I mentioned, with 15 percent; and Karaganda, in northern Kazakhstan. The national balance of fuels is such that a great deal of crosshauling is necessary, particularly with the higher grades. To an appreciable degree, coal must be hauled from western Siberia into central Russia--an enormously expensive operation.

In 1955 Soviet coal output, including lignite, constituted 391 million metric tons, rising to 429 million last year. But the bituminous coal equivalent is only 70 percent as great, because of the large inclusion of both lignite and lower grades of subbituminous coal. As a result, in terms of heat value, Soviet coal output is currently not the equal of the United States, but about two-thirds as great.

In addition, the quality of the fuel is lower than in this country. Only a quarter of the Soviet coal is beneficiated through washing. In the United States well over half is. The products sold in the American market are very highly standardized, not only through washing, but through blending to produce a product of guaranteed characteristics. Thus the quality of the product on the American market is so high that a substantial portion of our production is bought by Europe even though it requires premium prices. It pays the steel industry of the Ruhr to import American coal because of its superiority in performance in blast furnaces.

Let us discuss the problems of efficiency of production. There are two dimensions to this problem. On the one hand, there is that of strip mines; on the other, of underground operations.

The proportion of Soviet coal and lignite output from strip mines today is 17 percent, in comparison to 25 percent in this country. Soviet strip mines, in addition, are very highly concentrated. In the United States we operate 1,500 strip mines, each producing an average of some 60,000 tons a year. The Soviets operate only 42 strip mines, each producing an average of a million and a half tons a year. This economy of scale has very many reflections. In terms of physical output, as opposed to heat value, the Soviet productivity of labor in strip mining is 70 percent as high as ours, though because they largely mine lignite, it's only 40-45 percent from the heat standpoint.

In addition to this, they have realized economies of capital. Their strip mines are operated with only 713 power shovels and conveyors, as opposed to 3,400 in the United States. As a result, they have double the productivity of capital in this country. In general, their strip mining operations are efficient by any comparison.

Underground mining in the Soviet Union, however, is a much less favorable picture.

Now, the resource conditions in the U. S. S. R. are somewhat less favorable. The average width of seam is somewhat lower than in this country. It averages 4.2 feet, as opposed to 4.9 feet. And about a quarter of the seams operated are very thin indeed, although, correspondingly, they operate some seams much wider than are customary in this country. They also have problems of pitch in about 30 percent of their mines. The depths of operation are slightly greater. Ours rarely operate at depths under 200 feet theirs, 400 or 500 and sometimes even greater.

On the other hand, the Soviet Union has an advantage from the standpoint of concentration. The Ministry of Coal Mining, which produces practically all of Soviet coal, over 96 percent, operates only 930 mines; and its average mine capacity is over 300,000 tons a year. In the United States we operate 6,500 underground mines, with an average capacity of around 60,000 tons. In regard to overall efficiency, the questions of geological conditions and those of scale appear to be more or less compensatory.

For this reason we can examine other aspects a little more closely. One of the most interesting facts is that the capital availability of the Soviet underground coal mining is actually much greater than that of the United States. The aggregate installed horsepower capacity of Soviet coal mining equipment is a quarter greater than the American. The number of continuous coal cutters in the Soviet Union exceeds 2,000, as opposed to 500 in this country. They do have only 3,800 non-continuous coal cutters, as opposed to 12,000 in the United States. But they have 50,000 power drills, as opposed to 13,000 in the United States. Their conveyor equipment compares very favorably with ours; they have about the same number, 13,000, of electric locomotives. And yet the fact remains that the man-day productivity, excluding overhead, which is much greater in their case, is one-sixth that of the American mines.

Why? One basic reason goes back to the engineering design of their mines. Their mines are laid out, as most Continental mines are, on a long-wall system, with an advancing face. This means that they are constantly cramped in terms of operating space. They must devote very great energy to getting out the rubble. They have an almost insuperable problem in designing a continuous flow system. In the United States we use a chamber and pillar system, generally circular in design, with a continuous flow process and with a retreating working face. We cut first around the coal body and then go back.

This calls for higher initial investment. It calls for much better geological work, because, obviously, if you guess wrong in your design, the penalties in terms of coal losses are very heavy. In some cases it also calls for high losses of coal underground, where pillars must be maintained in order to save the roof. But in general, and in more recent years, caving has been practiced, so that the recovery of coal is not substantially less than in the long-wall system. In other words, the engineering layout of Soviet mines has been designed to get into production quickly with little information and at very low initial cost, and this is one reason for the difference in productivity.

Another reason is that their equipment is largely American in original design; it is a copy of equipment which is applicable to American practice and not to Soviet long-wall practice. As in the United Kingdom, where American coal equipment did not work out, the Soviets have found that they cannot gain much increase in productivity. In fact, despite the enormous increase in mechanization since 1940, productivity in underground mines is only 10 percent higher now than it was prewar.

Another factor is, of course, the immensely different quality in the labor force. The American coal miner is a really expert person. He's got to be in order to retain his company in business under intense conditions of competition. The Soviet coal miner is largely an inexperienced gentleman. Finally, such questions as maintenance and safety are involved. With trashy, dusty mines the Soviet Union has to maintain large crews for putting out underground fires and for mine rescue work. Ten percent of our underground people are in maintenance and reconstruction; 18 percent of the Soviets are in the field.

Now, let me go briefly over the petroleum and natural gas picture, which represents another viewpoint in regard to resource utilization both from the standpoint of successes and failures.

The Soviet Union has expanded crude oil production in a remarkable fashion since 1950. In general, its expansion of crude oil has been over half as great as that of the United States on an absolute basis--an achievement realized with only one-fifth as much drilling. Today, the Soviet Union produces 20 percent as much petroleum with some 15,000 operating wells, as opposed to over 300,000 in this country. (Its productivity is still substantially lower than the American--about 40 percent as high, because of much more limited automation in this field.)

The Soviet achievement has been realized by several methods. First, Soviet oil geology has been good for a long time. Their geophysics, including seismological experimentation, has long been excellent. As a matter of fact, the first Soviet computer (an analogue computer) that I know of was designed in 1940 for seismological work. In addition, they concentrated their efforts very heavily upon a limited area. Two-thirds of all Soviet petroleum today comes from a triangle to the east of the Volga, in the so-called second Baku area. In the Caucasus today, the fields actually produce only two-thirds as much petroleum as they did prewar--14 million tons as opposed to 21 million.

Now, these successes are marked, but they are also coincident with a marked degree of failure. On a theoretical basis we would expect Soviet refining to be very good. The Soviets have had a long and sound tradition in organic chemistry. In addition, they benefited from large-scale shipments of lend-lease equipment, including seven complete refineries of modern type, not as advanced as we have today, but including desalting units and other types of modern equipment. There is no lack of know-how here. Nevertheless, the Soviet petroleum refining industry is unbelievably lousy. In the first place, at the present time--this is material for 1953 and quite authentic--they recover only 53 percent of the crude input in terms of gasoline, naphtha, kerosene, and diesel fuels. In other words, 47 percent is residual fuel oil and losses. Refining losses average 12 percent of the input--a terrific quantity.

The quality of their gasoline is very bad. On the average it runs less than 60 octane in terms of the nonleaded stock. It has poor gum characteristics. It has high sulphur. In fact, it is lower in quality than prewar. The Soviet Union has no petrochemical industry worth talking about.

Why do all of these anomalies arise? I think the answer is very simple, and it is that the petroleum refining industry has had a low investment rate in recent years, because of its direct competition with atomic energy. The same basic processes, the same basic equipment, needed for petroleum refining have to be used for the separation of atomic isotopes. It is for this reason, rather than any inherent lack of know-how, that the Soviet Union faces a difficult situation in petroleum. This also means that much of its petroleum effort goes in a very inefficient way to produce residual fuel oil.

Now, let me go through an overall review of the fuel picture.

What is the energy balance of the Soviet Union? Well, overall, the Soviet energy supply today is a third of the American, compared to a fourth in 1940. However, while Soviet energy supply has expanded more rapidly than the American, it has remained structurally weak. Thus, the proportion of petroleum and natural gas in Soviet energy has risen from 20 percent in 1940 to only 23 percent today. Coal has remained stable at 50 percent. The proportion of very low-class fuels--lignite, peat, shale, and fuel wood--has remained stable or virtually so, at a quarter of the total. In contrast, in the United States the proportion of energy generated from petroleum and natural gas has increased from 44 percent in 1940 to over 70 percent today.

Now, what's the significance of this? Well, first of all, liquid and gas fuels are immensely less demanding in terms of labor than solid fuels. According to Soviet data of 1955, the productivity of labor in petroleum in terms of heat value produced is 4.4 times as great as in the coal and lignite industry. It's almost 12 times as great as in the peat industry; curiously enough, the Soviet peat industry employs far more people than does the petroleum industry. And natural gas is 2.7 times as efficient as petroleum. Thus, a tremendous economy in actual production results from the substitution of solid by gas and liquid fuels.

In addition, there are very great economies in transport and storage. Soviet coal mining requires 125,000 persons for industrial transport and warehousing alone, apart from those persons engaged in hauling coal on general-use railroad trackage. In the United States, all the pipelines for both petroleum and natural gas together require something less than 20,000 operating personnel. Furthermore, there are very great savings in steel input for railroad construction and other such uses. Finally, the efficiency of liquid and gas fuels is much greater in terms of application. Internal combustion engines, after all, run from 25 to 35 percent mechanical efficiency, as opposed to, say, five percent, for low-pressure steam; and efficient high-pressure steam turbines are very expensive indeed.

As a result, the effective energy produced in this country is still four times as great as in the U. S. S. R. but now we must also note differences in utilization patterns.

In the Soviet Union, household consumption of fuels, including cooking gas and all other purposes, rose only 25 percent between 1940 and 1955. Today, it is only a fifth of all of energy consumption, as opposed to a third in 1940. This actually represents a deterioration in energy availability per person, because, during the same period, the urban population has risen 50 percent, and urban requirements are higher than rural.

In the United States, in contrast, the household consumption of energy, including that for passenger cars, certainly exceeds 50 percent of our total supply, or about seven and a half times as great as the Soviet. Thus, what the Soviet Union has done has been to compensate for structural rigidity at the expense of the consumer; and the supply of fuel available for production purposes and for the military has in fact risen in comparison with that in this country.

Let me conclude with a few general remarks.

Natural resource exploitation has unquestionably been a major drag on the Soviet economy. According to Soviet figures, we know that the proportion of raw material expenditures in total industrial costs has risen from 44 percent in 1934 to 61 percent today. This is a contrast to the United States, where we have achieved a natural resource exploitation which is embarrassing in its efficiency, witness our farm problem.

Second, the factors involved in these questions of productivity and effective resource exploitation are extremely complex. There is no simple panacea of so much in the way of input and so much in the way of output. Economists love to play with these things, and for very general purposes they are satisfactory. But, gentlemen, there is tremendous elasticity in this area. Consequently, the only way to know how good or bad the Soviets are is to roll up your sleeves and get to know something about the particular field involved. This is a major caution, because of the constant temptation to generalize in this immensely difficult Soviet field on a very slim base indeed.

Finally, it is clear that the rationalization of the Soviet economy to meet the needs of an expanding population, further urbanization, and a stronger industrial base, let alone direct military demands, is an immense problem.

I still face great difficulty in conceiving how the Soviet Union can continue to reconcile healthy economic expansion with heavy military efforts. In fact, we have lots of evidence that it is not able to do so. We have the sputnik, it is true; but at the same time, this last year has witnessed a great many events showing excessive pressure on the Soviet economy, most notably the abrogation of Plan VI after 30 years and more of ordered economy. We can also note the repudiation of the internal bond debt and other measures of desperation.

For this reason, while the Soviet economy is dangerous insofar as it provides the base for the military striking arm, it is not in itself a source of primary concern for the West. If we guard against the striking arm, if we maintain a proper military posture, I think there is no question that the West will continue to have an enormous margin over the Communist bloc.

Thank you.

CAPTAIN OWEN: Dr. Shimkin is ready for your questions.

QUESTION: You mentioned incentives and particularly the lack of incentives in the coal mines of Russia. I wonder whether or not any of the other productive areas, such as agriculture, have really developed any method of incentives whereby the people can really get down and dig.

DR. SHIMKIN: Actually the coal mining industry, relative to the others, has had a maximum of incentives. Wage rates have been very high. But the trouble has been that living conditions, for example, housing and consumer goods supply, have been so very poor that the turnover rate has been enormous. They get, even in the engineering and technical staffs (according to a report of Bulganin a year and a half ago) a 40 or 50 percent turnover per year. Now, when you have that with mine directors, it just doesn't lead to a very good level of efficiency.

Agricultural incentives have been much increased over the past. For example, taxes on the private plot have been largely eliminated; and the returns for state payments for collective farmers have also been raised.

But this is still a relative problem. The farmer is dreadfully deprived. He or she still cannot leave the collective farm except through written permission from the manager. Everything is dictated in terms of mandatory time allotments. And at all times the farmer is a residual claimant. In years of bad crops you literally get to the point where there is nothing to distribute, and people have to live on what they earn on the side, for example, in seasonal labor. And this situation is a perennial one.

Now, the problem, of course, is that to give the peasant an equitable return requires a diversion of consumer goods and other real resources. This the Soviet regime simply will not do, because it jeopardizes its whole pattern of militarized industrialization. Therefore its choice has been a very small carrot and a very, very large stick.

QUESTION: Would you comment on the extent of public ownership of hydroelectric powerplants in the Soviet Union?

DR. SHIMKIN: One hundred percent.

QUESTION: Including small plants?

DR. SHIMKIN: Oh, yes.

QUESTION: What is the rate at which Russia is engaged in the stockpiling of metals and minerals?

DR. SHIMKIN: That is a very difficult problem for the current period, because of obscurity in regard to satellite consumption and Chinese consumption. We know, in copper for example, that the Soviet Union must reexport a good deal. The same is true of finished aluminum, as opposed to bauxite.

My general impression is that certainly since the end of the Korean War there has been mighty little stockpiling. They have had much pressure from both the construction program and the military program. The military segment has now a consumption of rolled steel nearly three times as great as it did at the beginning of the Korean War in 1950. Some of that may be stockpiled. We don't think there is much in view of the magnitude of their other programs.

I don't believe that they are planning any more on the old type of war. The cutbacks in the standing Armed Forces and other indications show that they are very, very much in the nuclear mood.

QUESTION: Do the Soviets have a serious industrial water problem?

DR. SHIMKIN: Yes. Very much so. This is again probably the reason why they have built up this extremely costly Volga project-- because of the paucity of good-quality industrial water.

It is true for two reasons. One is that the main area of industrialization has a pretty difficult runoff problem in general, a very small gradient and an irregular flow. In addition to this, it has had a tremendous pollution problem. They don't really have effective controls on industrial pollution. The plants get fined and they just go ahead and discharge more waste in it. The public health people are really in a very anxious state about it all the time. One of the reasons for their interest in, say, Siberia, the Angara Project and others, is to find a good source of industrial water. But this has problems again in terms of ice and so on.

I would say that the lack of good industrial water has been a real bottleneck for a number of their industries. For example, their copper mining in central Asia and Kazakhstan has unquestionably been held back by the lack of development of an effective water supply.

QUESTION: You spoke of the crosshaul taking so much of their resources. Several years ago I listened to a presentation of the deplorable state of their locomotives, particularly in burning peat and having to stop every 50 miles to renew their supply of peat. If that is correct, has it been improved since, or do they still have deficiencies in their equipment to move this material?

DR. SHIMKIN: The problem in Soviet transportation is exactly a parallel to the picture in the economy as a whole. Certain priorities are taken care of very well. They operate, and have always operated, an extremely efficient primary transportation system. In the Ukraine, central Russia, Leningrad, and western Siberia you have efficient operation, heavy-duty rails, a high degree of electrification, very heavy use of the trackage and of the rolling stock, and in general an effective kind of operation. This constitutes about 15 percent of the stations and a relatively small proportion of their trackage, but it also constitutes about 85 percent of their ton-mileage. In order to do this major job they have concentrated their efforts.

When you get to the secondary lines, you can meet any kind of poor situation that you could think of. But for their purposes this isn't so important. It would be important, however, if their primary systems were blocked or otherwise damaged. They would get into a very different problem.

But for a peacetime operation they do fairly well with this segmented and stratified transport system. It's very costly, because, for example, to reduce their turn-around time on their railroads, they use a million and a half people as freight handlers. They just get large gangs and clear out these freight cars as fast as they come in. That's a crude way of doing it, but it gets it done.

QUESTION: Doctor, I wonder if you would comment on some of the reasons behind this great contradiction you brought out today? The contrast between the technical weaknesses that you mentioned and the fact that these people are the first in so many fields, such as tanks and the other things that you mentioned.

DR. SHIMKIN: Well, it's part and parcel of the same picture. The Soviet Union is a country that has been mobilized for 30 years. Now, as a result of this mobilization and the rigidity of controls within the whole structure, they have invested very heavily in equipment and personnel in certain sectors. They have developed very specialized

institutions, for example, the Academy of Artillery Sciences, which is something we don't have in this country. It combines very high-level military instruction with first-class scientific research. And they have developed skills in certain segments.

But the Soviet Union, like any other country, has a finite amount of resources--a finite amount which is reduced by the essential wastefulness of a directed economy, a wastefulness which we also had in World War II. As a result of it, the other parts of the economy pay and pay very heavily. Now, this feeds back, because even their ordnance people have ultimately to depend upon inefficient raw-material production and intermediate processes. So that the two parts of inefficiency and very great efficiency are the reverse and the obverse of the same thing.

Now, the real problem--and I found this out again talking last week with operational people--is to convince our people that such a situation exists; that there is no contradiction; and that the real question is how to guard against the most dangerous aspect and how to increase pressure on the weak areas. But there is in the American mind a kind of naive simplicity. We see something good or we see something bad; ipso facto, it's all that way. It's a tremendous educational problem to get people to see the ups and downs deriving from the nature of the beast, inherent in a society bent on aggression. And if you fellows carry anything away from this course, I hope it is this understanding.

CAPTAIN OWEN: Doctor Shimkin, on behalf of all of us, I want to thank you for a very fine talk this morning.

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