

The Eastern Front at the Turning Point

Methodology and validity of a pioneering estimate of German supply and transport problems in 1941.

In December 1941, after General Winter had pinched out Hitler's spectacular six-month Russian onslaught just short of its objectives--Leningrad, Moscow, and the Donetz basin--and on the other side of the globe Pearl Harbor had brought America into the war at last, the question before the world was whether the hitherto invincible and still mighty German armies, when they renewed their offensive in the spring, could finish off the Russians and turn west again before the United States had time to gather the strength to be felt across two oceans. If they could reassemble anything like the power they had turned loose the previous 22 June, it seemed probable they could; but their supply lines were now almost a thousand miles longer than then, and the deeper they went the worse it would get. If transport had been a bottleneck for them in 1941, the Allies could be more sanguine about 1942 and would know better what their own strategy should be.

But had it? The task of answering this question was undertaken by the Office of the Coordinator of Information, a six-months-old hybrid soon to be split into the Office of Strategic Services and the Office of War Information, and specifically by its Research and Analysis Branch, a constellation of brains assembled by Wild Bill Donovan which was to become in one way or another the progenitor of many a production component in the present-day intelligence community. Before the winter was over these analysts had resolved the thousand and one shadowy unknowns of the problem into tables of hard figures on the German forces' supply requirements and the capacity of transport to their front lines and issued a 166-page report entitled *The German Supply Problem on the Eastern Front (June 22-December 6, 1941)*.¹

This was the first historic effort to devise a methodology for military-

economic studies of a kind that are now routine in the intelligence community, and if the techniques used and the resulting estimates seem crude, it is because there was no background of previous experience or knowledge from which to draw. Moreover, the analysts found that in those first months of U.S. involvement in the war the information available in government offices here was incredibly meager. They had to build up their estimates of German troop strength, for example, by attempting to reconstruct the campaign day by day and division by division from the *New York Times*. No one in Army Ordnance could give the slightest clue as to the probable expenditure of ammunition in various types of fighting. The analysts could not go either to experts or to sources; they had to become the one and to invent the other.

Twenty years later it is still instructive to review their search for sources and the hard thinking and mass of calculation that went into their reconstruction of what lay veiled behind the smoke of battle. It is also sobering, for all those that today must concoct estimates from scanty evidential ingredients, to compare their results with what has become known since they were published. The conclusions of the report pointed, if feebly and with hesitation, in the right direction; but the painstakingly derived figures on which these conclusions were based, it appears when they are compared with records in the diary of Franz Halder, Chief of the German army's General Staff, bore little resemblance to reality. While some of the component calculations that can thus be checked were about right and others were too low, the most important were so high that they threw the aggregate results off by four to five hundred percent.

Supply Requirements

The first job was to fix the tonnage of supplies of all kinds consumed daily at the front. A division's requirements would vary according to its strength, whether it was infantry, motorized, or panzer, and the kind of fighting it was doing. From the War Department's Military Intelligence Division and the *New York Times* figures were derived for the initial strength of the invading forces and their rate of attrition, the numbers and kinds of divisions in each of the army groups-North, Center, and South-and the T/O&E of each kind. For purposes of calculation,

divisional strength was assumed to remain constant, attrition being applied to numbers of divisions. To determine how many of each kind of division did what kind of fighting for how many days, an analytic study of the campaign as reflected in communiqués and intelligence reports divided it into eight manageable time periods on each sector of the front.² Seven types of action were distinguished, ranging from Inactive and Siege to Major Push and Heavy Fighting. The number of divisions of each kind engaged in each type of combat during each period on each sector were then tabulated and these figures combined to show division-days devoted to the different kinds of combat in each period. The results for infantry divisions are illustrated below.

Type of division and type of combat	Period	Period	Period	Period	Period	Period	Period
Infantry	I. June 22-July 17	II. July 18-Aug. 1	III. Aug. 2-Aug. 21	IV. Aug. 21-Sept. 25	V. Sept. 26-Oct. 20	VI. Oct. 21-Nov. 1	VII. Nov. 2-Nov. 17
Major push	1,330	78	372	841	606		100
Heavy fighting	830	954	563	1,215	400	50	230
Slow advance			160		270	660	730
Defensive fighting			315	1,020	240	120	
Reconnaissance	648	172	224	560	469	10	60
Siege					156	120	160
Inactive	1,222	766	1,026	1,404	1,187	480	640

The expenditure of supplies incurred on each of these division-days was calculated in seven categories—food, forage, clothing, ordnance, ammunition, fuel, and miscellaneous. Since food and clothing

requirements are a function of the number of men attached to a division, including varying allocations of non-divisional GHQ troops, the total number of the latter (estimated from MID information and analogous U.S. practice) were apportioned evenly for purposes of computation among the infantry, raising the 16,000 T/O of an infantry division to 27,000 men.

Food. The weight of a typical daily ration for one man at the front was computed, converted by multiplication to tons per day for each kind of division, adjusted for weight added (by making bread from flour, for example) or subtracted (as by dressing meat) at the distribution points immediately behind the front lines, and used as a constant throughout the campaign without regard to type of combat. Forage and clothing were also considered to be constants.

Forage. The number of horses used by an infantry division was estimated from the number of, horse-drawn vehicles (800-odd) in its *T/O&E* and multiplied by the weight of a daily ration of hay and grain. To this was added forage for livestock butchered to make up the soldiers' meat ration in sufficient quantity to take care of motorized and panzer divisions as well as infantry.

Clothing. Data was lacking on clothing requirements, but the item is such a minor one that a rough approximation (one ton per division/day) derived from British Ministry of Economic Warfare figures on "wastage factors" in the German army as a whole was considered adequate.

Ordnance. The weight of replacements for vehicles and guns in the complement of each kind of division was calculated on the basis of data from the U.S. Army's Ordnance Branch as a percentage of the weight of each original ordnance item. A distinction was made between active and inactive divisions in fixing rates of expenditure but not, on advice from the Ordnance Branch, among different types of combat. An additional ten percent was allowed for parts replacements, as suggested by the Ordnance Branch

Ammunition. Ammunition requirements were the most important variable with different types of combat. Unit-of-fire figures—the number of rounds fired from one weapon in an average day of active combat—used in the U.S. Army were adapted to German- weapons, and one unit of fire was allowed for a day of Heavy Fighting, with fractions of this for other types of combat. The weight of a unit of fire for each weapon in

each kind of division was then calculated to give the tonnage expended in a division-day of each type of action.

Fuel. The average distances moved per day in the field by different types of vehicle, as reckoned in U.S. Army staff work, were adjusted by factors reflecting the different types of combat, the movement of the front, and the kind of division in question and multiplied by the fuel consumption per mile of each kind of vehicle. To the resulting totals for all tactical vehicles of each kind of division in each type of combat were added five percent to take care of lubricants.³ It was estimated, however, that thirty percent of all trucks were not allocated to combat usage, but to bringing supplies forward from railheads and distribution points, and the fuel requirements of these were calculated separately as a function of the total tonnage of supplies that had to be moved to distribution points and to the front and of the distance from railhead to distribution point and from distribution point to the front. To this was added an estimated amount of fuel for ordnance vehicles brought forward from the railheads under their own power and an amount for conveying the fuel itself to point of use.

Miscellaneous. Five tons per division-day was allowed for engineer supplies; and the total tonnage covering all categories of supply was increased by five percent to take care of other miscellaneous materials.

The sum of all these calculations gave the total tonnage required at the front, at distribution points, and at railheads per division-day. The railhead requirements arrived at for infantry divisions are reproduced below.

(In Tons)	Heavy Fighting	Major Push	Slow Advance	Defense	Mopping Up (reconnaissance)
Food	33.8	33.8	33.8	33.8	33.8
Forage	38.0	38.0	38.0	38.0	38.0
Clothing	11.0	1.0	1.0	1.0	1.0
Ordnance	35.1	35.1	35.1	35.1	35.1
Ammunition	1,145.0	460.0	636.0	460.0	260.0

Fuel	49.9	74.5	38.5	38.5	58.1
Misc.	61.1	51.4	39.0	27.7	18.0
Totals	1,364	696	871	634	450

The multiplication of these figures by the previously calculated division-days for each kind of division gave the tonnage required by the ground forces during each period of the campaign. To these were added the relatively small air force supply requirements, calculated separately from estimates of the number and types of German planes at the front during the several periods of the campaign and from U.S. Army Air Corps logistics data adapted to German plane requirements. The total German supply requirements for the campaign were then tabulated as follows:

Front	I. June 22-July 17	II. July 18- Aug. 1	III. Aug. 2- Aug. 21	IV. Aug. 21- Sept. 25	V. Sept. 26- Oct. 20	VI. Oct. 21- Nov. 1	VII. Nov. 2-Nov. 17	VII. Nov. 18- Dec.6
Northern	765	303	410	1,047	362	155	240	323
Central	1,531	994	785	530	1,201	469	616	885
Southern	854	480	638	2,327	531	263	429	510
Total	3,150	1,777	1,833	3,904	2,094	887	1,285	1,718

Of the several possible modes of transport, it was considered that the use of coastal shipping, inland waterways, and air freight would have been quantitatively unimportant during this period ⁴ and that trucks

would have been used only as a substitute or supplement for rail transport. The capacity of the captured rail network, as the core of the supply problem on the eastern front, was therefore calculated with great care.

First came the question whether the broad gauge of the Russian railroads would have created a bottleneck. Four possible German solutions to this problem—reloading at the border onto broad-gauge rolling stock, using adjustable axles, changing trucks, and relaying the track at standard gauge—were examined, with the conclusion that the last alternative, converting the gauge, would have been the one adopted. It was calculated that 1000 crews of 30 men each could have done this job in 20 days for the 25,000 lan. of rail estimated to have been used in 1941, and that the discrepancy in gauge therefore did not delay the transport of supplies.⁵

It was determined that the captured rail lines usable to move up the German supplies were probably at first nine and then ten in number, six double-tracked and four single, one of the latter opened up only in mid-September. The number of trains that could be run daily over these were calculated, after extensive consideration of experience in other countries, reports on the quality of the Russian lines, and presumed wartime difficulties in their operations, to be an average 15 on single track and 45 on double as far as the major bases and 10 and 30 respectively beyond these to the advanced railheads. It was comparatively simple to estimate, from prewar German practice and experience in Europe and the United States, the carrying capacity (including service freight) of each train to be 480 short tons.⁶

From the number of trains that the rail net was thus estimated capable of carrying there were subtracted 55 trains per day for personnel movements—4,200 trains over the whole period for moving up reserves to the equivalent of 60 divisions,⁷ 1,875 for evacuating 750,000 wounded,⁸ 150 for evacuating 60,000 sick,⁹ and 937.5 for 1,125,000 on furlough¹⁰ —leaving 165 trains per day to the advanced railheads when all ten lines were open and 275 to the major bases. From the tonnage these could haul at 480 tons per train there was deducted twenty percent for service freight. The supply deliveries thus computed were then compared with the tonnages required in each period in the table reproduced in part below:

Thousands of tons	Period I	Period II	Period III	Period IV	Period V	Period VI	Period VII	Period VIII
Maximum available capacity for military supplies	No rail transport	100	100	100	106	106	106	106
Tonnage required at major bases	No rail transport	131	100	112	87	77	82	82
Surplus or deficit per day	No rail transport	-31	0	-12	19	29	24	24

Thousands of tons	Period I	Period II	Period III	Period IV	Period V	Period VI	Period VII
Maximum available capacity for military supplies	No rail transport	No rail transport	59	59	63	63	63
Tonnage required at major bases	No rail transport	No rail transport	85	95	74	65	70
Surplus or deficit per day	No rail transport	No rail transport	-26	-36	-11	-2	-7

Conclusions

Rail transport thus appeared to be inadequate to meet requirements at the major bases in two periods, II and IV, and at the advanced railheads in all. It was assumed that trucks would have been used to meet these deficits, 30-ton trailers to the major bases¹¹ and 5-ton trucks from there to the advanced railheads. It was calculated that in Period II 2,553 30-ton trailers would have been needed, and it was thought probable that the number available was "greatly in excess" of that.¹² 10,683 5-ton trucks would have been needed to fill the big shortage at the advanced railheads during Period IV, but this was only 62% of those estimated to be available for the purpose.

An intensive inquiry was made into whether there was enough rolling stock to make the indicated number of daily train deliveries. It was reckoned that a train would travel on the average only 60 miles a day,¹³ and in the final period, therefore, when the distance was greatest, 162,300 cars would have been needed. But this was only about 10% of the cars in Nazi-held Europe, and they probably could have been made available without critical strain. It was noted, however, that as the Germans pushed farther into the USSR the supply of rolling stock might become a serious problem; the same tonnage delivered to Stalingrad would take two and a half times as many cars as to Smolensk. It was also noted, without development, that getting the skilled personnel to operate the roads in Russia may have been a problem.¹⁴

The climatic conditions on the eastern front were studied mean temperatures, precipitation, drainage—from records of a score of years and comparison with areas of similar climate in the United States in order to determine when the weather and roads would permit the 1942 offensives to begin. The earliest possible dates were by this means calculated to be 6 and 15 April respectively for Rostov and Kharkov on the South front, 24 April for the Center at Moscow, and 9 May in the North around Leningrad. Attention was called, however, to difficulties encountered in operating railways in the winter, and it was suggested that especially on the North and Center the winter build-up might have

been so impeded as to delay the spring drives or weaken them by comparison with the preceding summer's.

The net estimate with respect to the future thus made a weak nod in the right direction. In 1942 there were no major German offensives at all on the North and Center, and in the South they got under way a month later than the estimated earliest, 8 May above the Crimea and 17 May around Kharkov. Three times in January Halder had remarked that the transport situation was "catastrophic," and on 18 and 21 March he was afraid that the way things were moving the build-up for the summer offensive would not be completed until August.

With respect to the past, what had happened in 1941, the estimate was right that there had been no over-all supply deficiency but that there had been temporary and local ones and that intervals of comparative quiet on the fronts reflected time required to build up supplies for a new push. But the aggregated figures for supply requirements and transport capacity supporting this conclusion were inflated by compounding errors to several times those revealed in the Halder notes and other sources.

Validation

In the first place, the military intelligence figures for initial German strength were too high—195 divisions, about 5 million men, as against 141 divisions totaling 3.2 million men.¹⁵ Each of 18 panzer divisions was said to be equipped with 430 tanks, a total of 7540, whereas Halder (22 September) gives the complement of a panzer division as 210 tanks. This would make 3780 tanks for 18 divisions, but a generally accepted figure is 3200, and Von Thoma says there were only 2,434 frontline tanks to start.¹⁶ On the other hand, cars and trucks estimated to be in the divisions' T/O&E's would total only 374,000, whereas Halder (18 November) gives the starting number of 500,000.¹⁷ But the estimate assumed that all these vehicles, as well as guns and other equipment, were replaced as they were expended except as it applied attrition to the total number of divisions, whereas at a time when cumulative attrition was figured in the estimate at only 2.5% Halder noted (11 September) that tanks were down 40%, cars and trucks 22%, and

tractors over 30%. On 18 November, when the estimate counted attrition 12.8%, he recorded cars and trucks to be off 30% (and another 55% needing repair). By the following March, according to one hardly credible statement, there were only 140 serviceable tanks left in all.¹⁸

When it came to ammunition requirements the error had snowballed to something like 800%, at least over one of the eight periods. Halder observed on 16 August that total expenditures of ammunition over the preceding 15 days amounted to 340 trains. At 370 short tons net per train this would be 123,800 tons or an average of 8,220 tons per day. The estimates figures for division-days of each kind of fighting multiplied by ammunition requirements for each for Period III, 2-19 August, give 1,255,563 tons, an average of 66,082 per day. Yet for a particular sector during this period the estimate was three times too low. Halder remarked' on 3 August that North was supposed to get 7 to 8 munitions trains daily, that is 2590 to 2960 short tons, whereas the report's tabulation showed a requirement in this sector at this time for only 920 tons.

The estimate of fuel needs was low in the one period we can check it. Halder complained, on 26 September that the three fronts would get only 26 trains of fuel daily against requirements for 30. 30 trains would carry 11,100 short tons, 26 trains 9620; the estimate reckoned for this period division day requirements that total only 6525 short tons, to which a small unspecified amount should be added for truckage from the railheads.

Over-all, the overestimates greatly outweighed the underestimates. An infantry division doing heavy fighting was calculated to need 1364 tons per day, almost twice the 700 tons Von Paulus, cut off a year later at Stalingrad in presumably much heavy fighting with the equivalent of ten divisions, said he would need to get by air, and not much less than the 1500 tons he said he'd later need when his stores ran out. Probably the greatest single source of error in estimating requirements was the unspoken assumption that except for the 12.8% attrition allowed in numbers of divisions the armies had been kept up to strength in men and material, whereas in fact they had fallen to about half of original combat strength.¹⁹ While in some sense such replacements are a requirement, it had clearly not been planned to make them until the 1941 campaign was over.

In order to maintain the "approximate equivalence" the report arrives at

between requirements and transport capacity it therefore had, in spite of overestimating the net tonnage carried by a train, to show a capacity for four or five times as many supply trains daily as there actually were. Halder provides a direct check in this matter. He did not distinguish between major bases and advanced railheads, usually tabulating train arrivals simply to the North, Center, and South army groups; but once (29 November) he specified Smolensk and Gomel, the major bases for Center, and once (7. August) he observed that heavy truckage could bridge the 400 kilometers to Leningrad, Moscow, and Poltava from the railheads, again clearly major bases. It is with the report's estimate of 275 supply trains daily to these, then, that we must deal.

Toward the end of July only 30 or 40 trains were arriving daily for all fronts. On 7 August Halder noted that the number should be increased to 58. By 11 September it was up to an average 59. At this point it apparently ceased to be a source of worry; there are no further diary tabulations until the time of the last desperate effort to take Moscow. On 29 November a six-day tabulation showed the Center getting an average of 2 more trains than in September, 31 instead of 29.²⁰ But on 3 December it was observed that of the total 122 trains daily in the east 67 would after 15 December be used by the Quartermaster General ²¹ and another 13 for troop movements, leaving only 42 to supply the army groups.

In one of its major premises, at any rate, Halder vindicates the estimate. On 19 November he quoted Hitler as declaring that the objectives of the 1942 campaign, beyond the Caucasus in the south and Vologda or Gorki in the north, "must remain open; they will be determined by the performance of our railroads." Imagine the effect on world history if his armies had really got 275 trainloads of supplies per day.

For all its failings this study, as a prototype, had important repercussions. It pointed up the lack of data and the fuzziness of estimates on enemy capabilities and so led to an expanded-now vastly expanded-effort in this field. The next step was to examine the European Axis economy to see whether it could support the war effort that had been presumed-steel, manpower, chemicals, petroleum, etc.²² The large economic intelligence organizations of today had their origins here. A further significant offshoot of the prototype because of the detailed knowledge of the enemy economies and their civilian-military interplays gained in its successors, was a series of studies on target selection and target system appraisal for the bomber forces, the beginnings of air

targetin-E as we know it now. Here military and civilian intelligence of forts began to blend in a fruitful combination that still continues. The operations analysis offices in part and much of the armed services' present intelligence shops, for example the Air Force Intelligence Center, find their roots here.

1 COI Monograph No. 6, 25 March 1942, Confidential (later declassified). An embarrassing blemish was imposed on the nose of this impressive document by the typist, who changed the 1941 of the title to 1942. Among those who participated in the preparation of the report were W. W. Rostow, now policy planner at the State Department, E. A. Mayer, now with the Institute for Defense Analyses, Samuel Van Hyning, Chandler Morse, now professor of economics at Cornell, and Donald Wheeler.

2 The analysis erred in making the first period "a generalized push across the frontiers" and saying that the "regrouping of the German armies under the three commands [North, Center, South] . . . took place only on July 17." The three command groups were set up by the original Directive 21 issued the preceding December. It also erred in seeing "a major shift in Nazi strategy . . . during the campaign" from the aim of destroying Russian military resistance to that of "seizing and holding important territories and cities." Directive 21 named as objectives the capture of Leningrad and Kronstadt, the occupation of the Donetz basin, and the capture of Moscow, in that order, and the enemy forces were to be destroyed in the course of reaching them. These two aims did seriously clash once in August, when Hitler, over the opposition of most of his generals, diverted part of Army Group Center from its drive on Moscow to help Army Group South destroy the huge bulk of Budienny's army group in the battle of Kiev, which Hitler called "the greatest battle in the history of the world" and Halder "the greatest strategic blunder of the eastern campaign."

3 Halder noted on 11 August that two percent was normal but current consumption was running five.

4 This premise was apparently correct. Halder made reference to a number of shipments on the order of one or two thousand tons coastwise to Riga and on Lake Peipus but implied that he did not count

on these supply lines.

5 This reasoning apparently coincided with German expectations. During the planning for "Barbarossa," as the Russian campaign was called, Halder noted (3 March) that a railway battalion can convert Russian track to German gauge at about 20 km. per day (at 200 working men to a battalion this is more than twice as fast as estimated above) and that these battalions should be in the van of the advance, right behind the panzers. But in practice the conversion cannot have been made so rapidly and completely. On 2 August, six weeks after the invasion, Halder gave as the number one reason for the persistent inadequacy of rail transport the shortage of Russian rolling stock, especially locomotives, and its poor state of repair. The only line he mentions having been completed in standard gauge (18 August) was that through the Ukraine (Chernovtsy) from Poland to Rumania. And as late as 5 December, toward the end of the period studied, he complained that the Russians had completely destroyed the repair shops for their locomotives and the German locomotives could not stand the cold, but reiterated that plans called for "the gradual elimination of the broad gauge." Both gauges must therefore have been in use for some time.

6 This is a bit high, according to a notation of Halder's (1 July) equating 9000 cubic meters of motor fuel with 22 trains. The net load of each train, 410 cubic meters of oil, would weigh about 335 metric or 370 short tons. The estimate's 480 reduced by 20% for service freight would be 384 short tons.

7 More than five times too high. The entire reserve force comprised only the equivalent of 11 divisions at the estimate's 27,000 men per division (Halder, 16 June and 2 August).

8 This is high. On 2 October, 18 days past the mid-point of the period, Halder counted 368,000 evacuated, probably both the wounded and the sick. The casualty count for 10 December has 580,000 wounded.

9 Not in addition to the wounded, but the figure seems too low. On 7 September, after only a month and a half of fighting, Halder noted that there should be added to the casualty figures 400 sick per division, a total of 56,400. Elsewhere he excludes the sick from casualty counts. On 21 November he observed that the current ratio of wounded to sick, formerly 1:4, had risen to 1:1.4, but these cannot all be evacuees.

10 Halder has nothing bearing on this figure, but one suspects it should

be divided by about 10.

11 Halder makes several references to such supplementary heavy trucking all the way from Poland, but none after 24 August, about the end of Period III.

12 In tons this would be 76,590 short or about 69,500 metric. On 26 April Halder gave the (presumably heavy) transport tonnage planned for Barbarossa's three fronts and GHQ as 67,240 (metric) but as early as 10 July noted that 25% of this was out of action. On 15 July the Center army group, which was having particular difficulty with rail transport, had 30,700 tons of heavy trucks mobile. On 5 March of the following year the total available tonnage was 50,000.

13 In recording an incident of some lost and badly needed munitions trains, Halder (3 August) expected them when found to make it from Warsaw to Velikiye Luki (about 200 miles) in one day. He has nothing really bearing on the 60-mile average.

14 It had. Halder complained (4 December) that instead of 16 men per kilometer there were only 10, of which only one was German.

15 Halder, 21 June et passim.

16 As quoted by Walter Goerlitz in *The German General Staff*.

17 The estimated number of horses, 589,000, was also a little low. Haider, when he noted that 1,100 were dying daily of the cold, indicated that the total had been 640,000 (7 December) .

18 Wm. L. Shirer, quoting a German army report in *The Rise and Fall of the Third Reich*, p. 909.

19 Halder, 30 November.

20 Including an average 6 or 7 "farther to the rear" than Smolensk and Gomel.

21 Presumably for wintering requirements, among them the 300,000 barracks which Halder had noted (2 August) were being built and would require 255 trains.

22 These studies led quite soon to modifications of several of the military consumption estimates discussed above. Within a few months

the estimate of ammunition consumption was reduced by some 60%.

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