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BOARD OF ECONOMIC WARFARE
Economic Potential Division

RESTRICTED

TUNGSTEN POSITION OF THE EUROPEAN AXIS

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Summary

Requirements: The European Axis requires 3,590 metric tons of tungsten concentrates a year in order to maintain its capabilities.

Supply : The European Axis will probably have a supply of 4,500 metric tons of tungsten concentrates in 1943. Of this, more than nine-tenths will originate in the Iberian Peninsula.

Deprivation: Reduction of supplies will not have major effects unless supplies from the Iberian Peninsula are reduced to below 3,000 metric tons.

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I. TUNGSTEN REQUIREMENTS

The annual tungsten requirement of the European Axis has been estimated to be as low as 4,000 metric tons of tungsten concentrates, and as high as 7,000 metric tons. The Ministry of Economic Warfare estimate is 5,000 metric tons of concentrates. In the lack of adequate information as to the methods employed in reaching the available estimates, a calculation has been made, based on the known United States consumption for 1942 and estimates of the proportion thereof "required" by the European Axis.

The concept of "requirement" is frequently used with a casualness which leads to highly unrealistic conclusions. To cut supply by one ton has vastly different effects, depending on the level at which the cut occurs. If the Germans had 50,000 tons of tungsten, a cut of one-half would have no effect whatever on the war. If they had 2,000 tons a cut of one-half would have a direct effect upon highly important uses. The purpose of estimating the European Axis requirement is to fix as accurately as possible the level at which there occurs the sharpest decline in the essentiality of additional supply.

In the United States the use of tungsten has been increasing with the expansion of war production, and the estimated requirement for 1943 is substantially higher than the actual consumption in 1942. Since the actual consumption in the first quarter of 1943 is only a little above the 1942 level, and substantially below the 1943 requirements estimate, it has been assumed that the consumption of tungsten in the United States in 1942 may be used as a fair basis from which to compute the relative requirement of the European Axis.

United States consumption by end product categories was:

Tool Steel	64 Percent
Aircraft Parts	12 "
Projectiles	8 "
Other Tools, Dies, etc.	8 "
Filaments, Compounds, etc.	6 "
Dyes and Colors	2 "

The total United States consumption of tungsten for 1942 was 17.2 million pounds metallic content. German use, however, differs markedly from United States use in the following respects:

Cutting Tools

The use of tungsten carbide in Germany affects enormous economies as against the use of tungsten-steel in cutting tools. This superiority is reflected in estimates that one pound of tungsten

in carbide will serve to remove as much metal in machining operations as 70 to 100 pounds of tungsten in tool steel. In addition, tungsten steel may be used as a bit fitted on the end of a carbon steel shaft, or a tungsten steel layer welded along one side of a carbon steel shaft, requiring somewhat more work in the production of tools, but saving great quantities of tungsten. The United States' practice is still uniformly to make the entire bar of tool steel. According to opinion obtained from a [redacted] source, the Germans probably save 80 percent, and may very readily save 90 percent, as against the American use of tungsten in cutting tools for the same kinds of operations. As a practical basis for calculation, it may be concluded that the European Axis can meet all cutting tool requirements on 25 percent as much tungsten as the United States. This is a very liberal allowance, considering the evidence available.

Aircraft Parts

According to the best available information the Germans make very little use of tungsten in airplane engine parts, depending upon chrome- or nickel-steel instead.

Therefore it was concluded that the European Axis requires no tungsten for aircraft parts.

Projectiles

It is apparently [redacted] the use of tungsten carbide [redacted] anti-tank ammunition should be considered a highly [redacted]. The value of tungsten carbide cores in such ammunition appears to be based on the very high weight-for-volume attained. Such cores have been used in all calibres of ammunition up to 76 mm. It is argued that the use indicates that the Germans consider this essential. It may be pointed out, however, that such use has been most noted in North Africa, and that North Africa was a field of action where any saving in ton-miles of transport was very important. To knock out tanks with super-velocity ammunition of relatively low calibre may have been a definite advantage as compared with the alternative of bigger guns and heavier ammunition. North Africa was commonly referred to as "a tactician's paradise and a quartermaster's hell". The defense of Europe is a very different proposition, involving positions on which the Germans have had three years to lay down ammunition stocks where they want them, and where in any case their supply lines are much shorter than they were in Africa.

Various opinions have been obtained, including both War Production Board and Army Ordnance, which agree that tungsten carbide cores for projectiles are relatively non-essential, and that the German capabilities would be substantially unaffected by giving them up. The Army also stated that such ammunition is not now used by the

United States or its allies; that so far as is known there is no intention to use it; and that even at present a far larger proportion of German armor-piercing ammunition has the conventional hardened steel core. The DKW does not disagree with the British estimate on past use of tungsten for this purpose, but does not regard such use as essential. The Board, therefore, stands on the conclusion that such use reflects ample supply rather than serious need, and that deprivation of supply inhibiting this use would not have a serious effect. Therefore, as a practical basis for calculation, it is concluded that the European Axis has no necessity for tungsten in projectiles.

Other Tools and Dies

The rubric "other tools and dies" in the United States list of uses includes a rather loose assemblage of items, covering the entire range from convenience to necessity. As a practical basis for calculation, it may be concluded that the Germans might require 50 percent as much for this use as does the United States.

Filaments, etc.

The use of tungsten filaments in electric light is susceptible to a large degree of conservation. The use in radio tubes, radar, and other special equipment is impossible to estimate, though the proportion is probably closely parallel to that in the United States. As a practical basis for calculation, it is concluded that the European Axis requirement may be 50 percent of the United States figure.

Colors and Dyes

The continued use of tungsten in colors and dyes could only reflect an easy supply situation.

No allowance is necessary in this connection.

General Observations

The United States' allocation pattern must be understood in the light of its supply situation. United States requirements estimates exceed its estimates of new supply by a few thousand tons; but its stockpile is large enough to cover the deficiency for several years, and consumption has run lower than estimated. With all due regard to security of essential raw material, therefore, the United States is able to use tungsten without the most rigorous conservation. This implies that the Germans may save a good deal on the periphery of all uses, and that the German requirement should be less in proportion to the general economic scale.

The Germans are also using less steel for construction or ship-building than the United States, and more steel in highly fabricated form. The Germans, therefore, must use cutting and other tools on a greater scale in proportion to total steel production.

The German economy, taking steel as a base, is about four-ninths as large as the United States' economy. This ratio, applied to requirements without any allowance for differences in use pattern, would result in an estimated German requirement of 7.73 million pounds of metal or 7018 metric tons of concentrates of 50 percent metal content. This figure is certainly much too high for any realistic meaning, and is offered only in order to show the necessity of weighting the estimate for variations in uses.

Recapitulation

The most reasonable basis for calculation of European Axis requirements from the United States use pattern would be on the basis outlined above. The allowances made seem sufficiently liberal, on the evidence, to cover any minor omissions or underestimates. The calculation leads to a European Axis requirement estimate of 3.95 million pounds of metal, or 3583 metric tons of concentrates of 50 percent metal content. This is summarized in the table below.

Use	U.S. Consumption (percent)	U.S. 1943 Consumption (million lbs. of metal)	Est. German Req. as Fraction of U.S. (percent)	German Requirements (million lbs. of metal)
Cutting Tools	64	11	25	2.75
Aircraft Parts	12	2.06	None	--
Projectiles	8	1.37	None	--
Other Tools & Dies	8	1.37	50	.68
Filaments, etc.	6	1.03	50	.52
Colors & Dyes	2	.34	None	
Total		17.2		3.95

The above table is not presented as a pretended profile of German requirements in detail. What is claimed for it is, that it establishes more accurately than previous estimates the general level of tungsten supply essential to German economic and military potential, and gives a more realistic basis to the concept of requirements. The allowances made as fractions of the United States use pattern are so liberal in the light of all evidence that the total is probably too high rather than too low.

This calculation is in close agreement with the British estimate of the requirement for filaments. It is very much lower than the British estimate for high-speed steel and tungsten carbide tools combined, allowing only 2,500 tons for this purpose, against the British allowance of 3,500 tons. The most marked difference is in the allowance for projectiles; the British include 1,500 metric tons and [redacted] includes none at all as an essential requirement.

Unless the supplies of tungsten concentrates to Germany are reduced below 3,500 metric tons per year, German metallurgical production, and German production of electrical equipment including bulbs and vacuum tubes, will not suffer.

II. SUPPLIES

Estimates of German supplies range from 4,500 to 4,900 metric tons of tungsten concentrates a year. Of this the estimated supply from Portugal to Axis Europe is 3,800 tons. The estimated supply from Spain is 1,500 to 1,800 tons. All other supply amounts to only 200 or 300 tons, unless blockade running amounts to more than is estimated.

III. EFFECT OF DEPRIVATION

Any attempt to reduce German tungsten supplies through action affecting the supply obtained in the Iberian Peninsula must reduce this supply from the present estimated 4,300 - 4,800 tons to less than 3,000 tons before it will begin to have a direct effect on German capabilities. Any lesser degree of reduction of supply will cost the Germans additional trouble and skilled manpower in conservation practices, or a minor degree of sacrifice in the quality of such products as projectiles.

The effect of any deprivation of new supply will be cushioned by new conservation and recovery methods, so that a reduction of new supply by, say, one-half, will by no means lead to a reduction by one-half in use of tungsten. The economic consequences will be still more attenuated, for the uses cut off will be less essential than the uses retained.

Any reduction of new supply from present levels will have only nuisance value unless the new supply is cut below 3,500 metric tons. Below about 3,000 metric tons, further reductions will begin to have really serious effects in higher costs and lower quality of substitutes. This does not mean that reductions in the higher levels will have no effect, but that the effect of a reduction of supply from, say, 5,000 to 4,000 tons, would be very small compared to the effect of a reduction from 3,000 to 2,000 tons.