A Working Paper Draft

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EXAMPLE OF USE OF CHECKING CHART, PART II: TIME SCALE OF ATOMIC ENERGY DEVELOPMENT, ESTIMATING PRIMARY PILE LOCATIONS, SECONDARY PILE LOCATIONS, ATOMIC DEVELOPMENT AUTHORITY.*

*SEE SEP NO. 14-A FOR ORIGINAL TITLE.

These notes were part of a paper presented in the graduate seminar on atomic energy control mentioned in SEP No. 11-A, page 4.

Reference is made to this material by Walter Isard in "Some Economic Implications of Atomic Energy." Quarterly Journal of Economics. V. 62 (1948), pp. 202-228, citation on p. 223.

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EXAMPLE OF USE OF CHECKING CHART, PART II: TIME SCALE OF ATOMIC ENERGY DEVELOPMENT, ESTIMATING PRIMARY PILE LOCATIONS, SECONDARY PILE LOCATIONS, ATOMIC DEVELOPMENT AUTHORITY.

Abstract

An approximate time scale for atomic power development is projected on the basis of 1947 information. Then a technique for estimating the locations requiring primary piles is developed. The rate of growth of elective power production of U.S.A., World Hydro, U.S.S.R, Czechoslovakia, Mexico, and Moscow are plotted. The tables are prepared of potential primary pile locations. A map of proposed Atomic Development Authority Regions is included.

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3. Time Scale for Atomic Energy Development.

The General Electric Co.[1] has estimated that a design for an atomic power plant can probably be completed by 1953. From this point one can make a rough estimate based upon previous industrial experience in the introduction of new industrial equipment. Such a rough estimate is tabulated in Table I.

Table I

Estimated Time Scale for Design and Construction of Atomic Energy Piles.

Year	Stage of Development
1953	Complete design of prototype
1955	First operating trial plants
1960	Five to eight primary piles installed by this time
1970	Rate of installation of primary piles between two and three per year. Installation of secondary piles under way

A rough estimate of the possible production of electrical energy from atomic energy for the period 1955 to 1980 is plotted in figure 6. A plant factor of 50 (4380 kw-hr per year per kw installed capacity) is used. The approximate conversion factor of 1000 kwh per metric ton of coal is based on 9060 Btu per pound of coal and a plant efficiency of 20% for steam plants.

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1. (Documentation required for publication)

4. Technique of Estimating Primary Pile Locations.

The following conditions are used in picking locations for primary piles.

(1) Need for an extra 200,000 kw electric generating capacity in an area of approximately one hundred miles radius.

(2) Shortage of cheap natural power sources near the area.

The question of need idealistically could be approached by examining figure 5 and picking out the countries with the lowest per capita production of electric power. Practically it is not as simple. For additional electric power to be a social benefit in a particular area, the people of the area must be prepared for industrial expansion to use the additional electric power. This means that only areas which are already well developed industrially will be able to utilize primary piles. However, secondary piles can be used in backward areas, at remote mines, and at smaller industrial areas to help equalize the industrial development of the world.

The total world production of electric power is assumed to rise exponentially like the raw materials discussed by Dr. Hogbom, except when stopped by war and economic disturbances. The electric power production of each industrial area or country is assumed to start irregularly, then approach an exponential curve as it is going through its major industrialization, and then continue to increase but at a slower rate after the area attains a well integrated state of industrialization. To partially check this assumption, refer to figure 4 for total

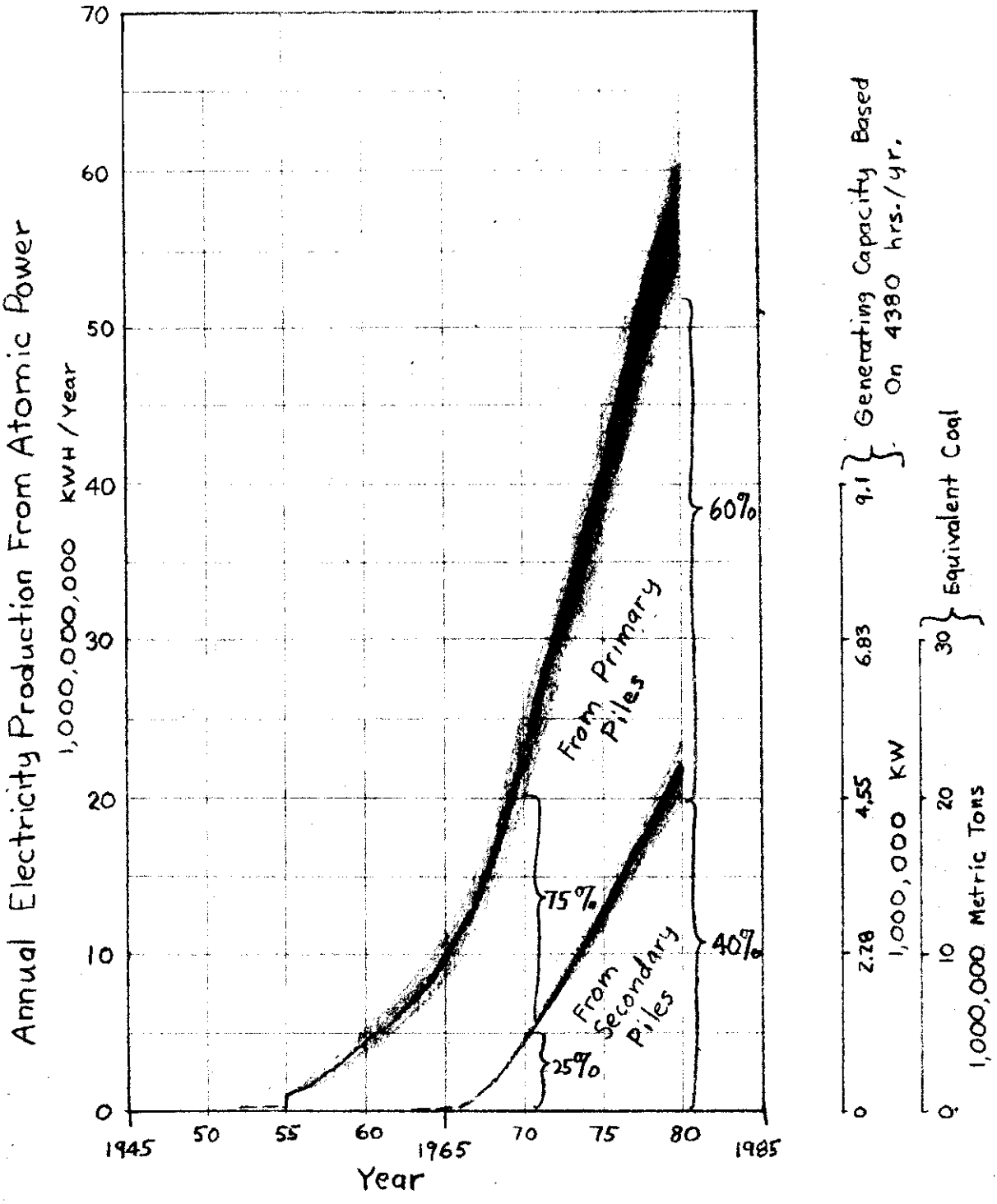

Fig. 6 - Estimate of Possible Electrical Energy Production From Atomic Energy For 1955 - 1980

world electric power production and to figure 7 for some sample areas and countries. The electrical energy production of the U.S.A.[1] plotted on semi-logarithmic paper in figure 7 agrees approximately with the above assumption. The estimated values for 1950 and 1960 are from the Twentieth Century Fund Report.[2] The U.S.A. has been doubling electric energy production every ten years. The doubling period for the Moscow[3] area approached 3.5 years and for the U.S.S.R.[3,4] approached 7 years before the war. The per capita output of electrical energy can be used as an estimate of extent of industrialization for determining if an area can still absorb electrical energy at the maximum stable rate of increase. Per capita indicators are shown in figure 8 for the Moscow system.

As a sample region, consider the U.S.S.R. It has been shown that Moscow needs at least 200,000 kw additional capacity. Similar data is available for Leningrad. It is estimated that the Stalingrad, Chelyabinsk-Sverdlovsk, and Tomsk-Novosibirsk areas could use more than 200,000 kw additional capacity, but there the question of extent of other low-cost sources of power requires further study. By study of figures

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1. Data from Gaffert, Steam Power Stations, 3rd edition, McGraw-Hill Book Co., p. 5, 1946.

2. "U.S.A. 1950-1960," Business Week, supplement, April 26, 1947.

3. Data from Business Week, p. 113, Nov. 10, 1945.

4. Data from Academia Nauk, Electric Power Development in the U.S.S.R., Moscow, 1936.

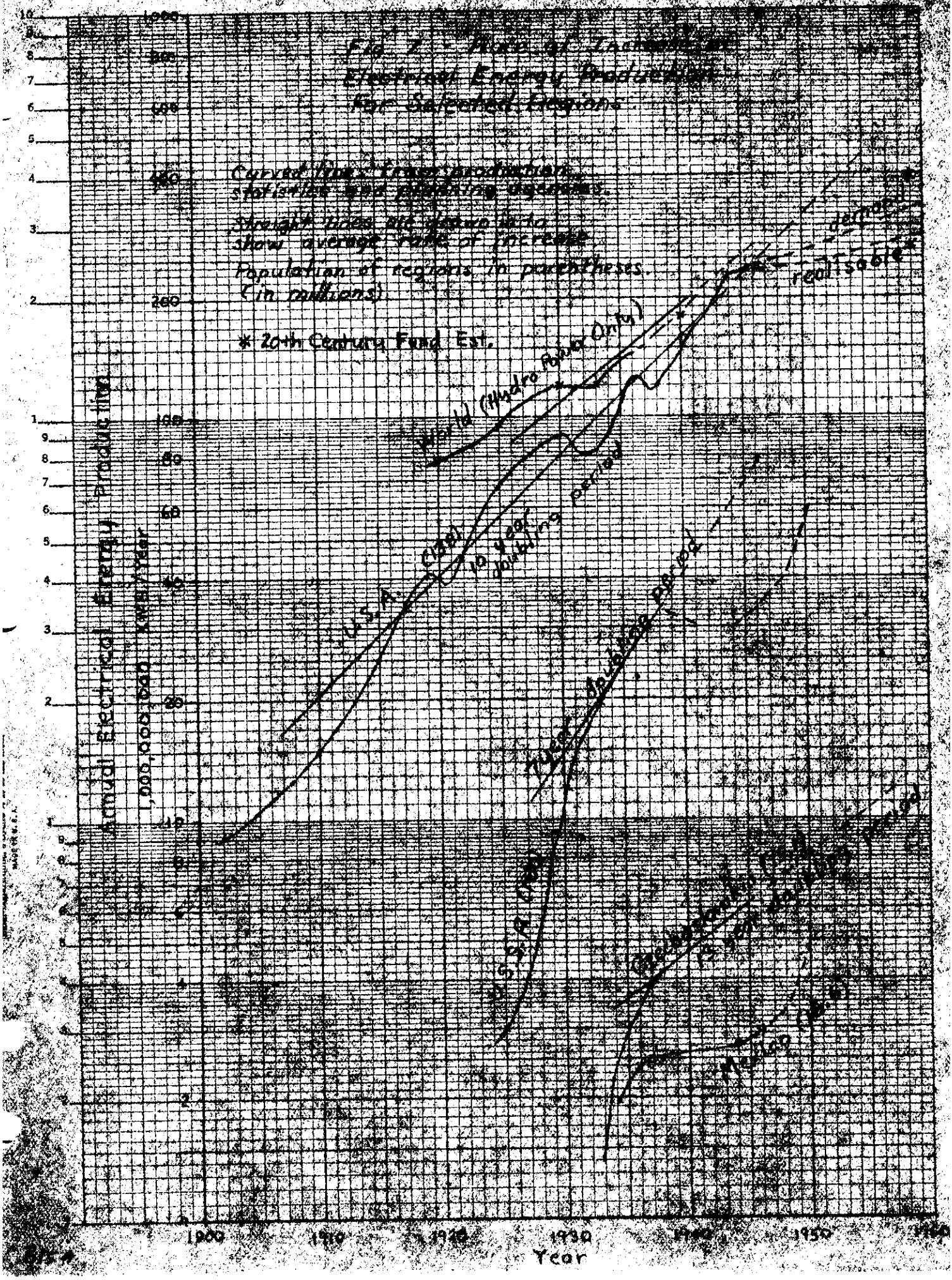
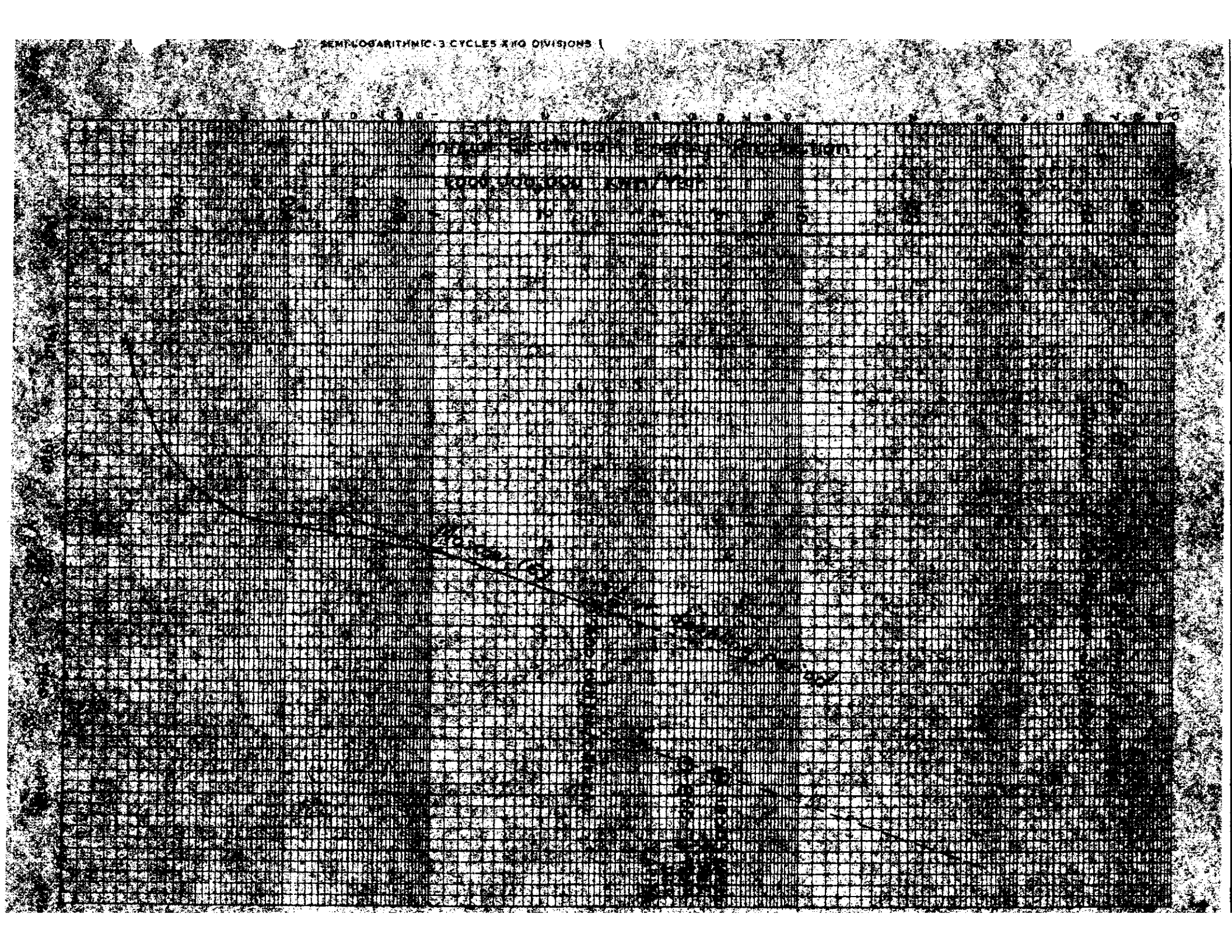


Fig 2 - Rate of Increase of Electrical Energy Production for Selected Regions
Curves fitted to power production statistics and planning agencies.
Straight lines are drawn to show average rate of increase
Population of regions in parentheses. (in millions)
* 20th Century Fund Est.
Annual Electrical Energy Production
1,000,000,000 Kwh/year
Year
1900
1910
1920
1930
1940
1950
1960


SEMI-LOGARITHMIC - 3 CYCLES X 70 DIVISIONS

Illustrations from:

Academia Nauk, Electric Power Development in the U.S.S.R. Moscow, 1936

Fig. No. This Report	Fig. No. Source	Title
9	90	Cost of hydroelectric energy in the river basins of the U.S.S.R.
10	105	Comparative advantages of hydroelectric stations and steam-electric stations in the principle areas of hydroelectric construction in the U.S.S.R.
11	28	Cost of various fuels in the regions of the U.S.S.R. Power Resources of the U.S.S.R.
12	-	Power Resources of the U.S.S.R.

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Figs in Box E: 4701

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9-12 [1] on hydroelectric costs, steam station costs, fuel costs, and power resources, the Stalingrad and Tomsk-Novosibirsk areas can be eliminated as having plentiful sources of low-cost fuel. However, it should be remembered that the data used here is from a 1936 report and changes in the situation may require consideration.

5. Estimate of Primary Pile Locations.

The other countries of the world were considered by similar methods to the extent that data was available. The suggested locations for primary piles are tabulated in Tables II and III.

Table II

Areas which can Use Atomic Primary Piles in the Late Fifties.

(Area); (Country)

Copenhagen; Denmark (Research Center)

Chelyabinsk-Sverdlovsk Area; U.S.S.R.
U.S.A.
Manchester; England
Paris; France

Leningrad Area, Moscow Area; U.S.S.R.
Buenos Aires; Argentina
Wien; Austria
Belgium
Brno-Plzen-Praha; Czechoslovakia
Birmingham, London; England
Marseille; France
Genova-Milano-Torino Area, Roma-Napoli Area; Italy
Netherlands
Warsaw; Poland
Glascow; Scotland
Madrid; Spain
Leningrad Area, Moscow Area; U.S.S.R.

[1] Figures from Academia Nauk, Electric Power Development in the U.S.S.R., Moscow, 1936. For a more detailed study, these should be supplemented by the data in the Bolshevik Atlas (1937) and the current Five-Year Plan.

Table III

Areas which probably can use Primary Piles Later than the Fifties.

Peiping-Tientsin Area, Nanking-Soochow-Shanghai Area, Canton-Hong Kong Area; China
Bombay Area, Calcutta Area; India
Hiroshima-Yawata Area, Osaka-Kobe-Nagoya Area, Tokyo-Yokahama Area; Japan

Germany was omitted from consideration at this time. No attempt has been made to estimate locations in the United States. In the case of Japan the establishment of primary piles is subject to restrictions to be established on Japanese industry by the peace treaties. Most of the industrial areas listed as having need for primary piles later than the fifties are so listed because their industrialization has not been very significant to date.

There are some areas where electric power is usually considered in conjunction with some other activity. Where irrigation is of prime importance, atomic may not be as desirable as hydroelectric power. In northern areas where steam for heating purposes is obtained from electric power plants, atomic energy may be particularly useful. Perhaps it may be possible to use atomic energy piles primarily for heating steam in some places.

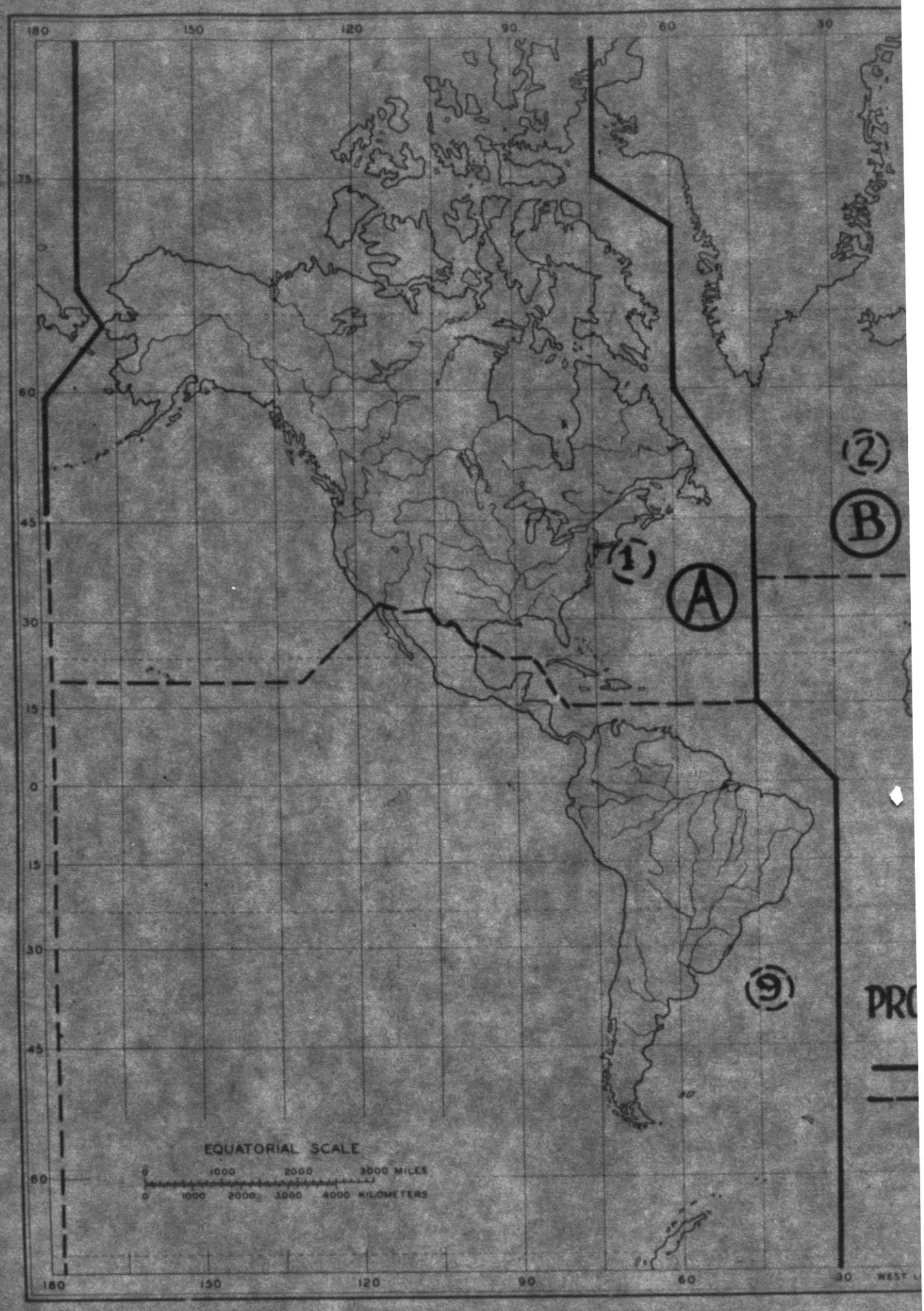
6. Secondary Pile Locations.

No detailed analysis is here attempted. It appears reasonable that atomic energy could be utilized sooner in India and China by the use of small secondary piles during

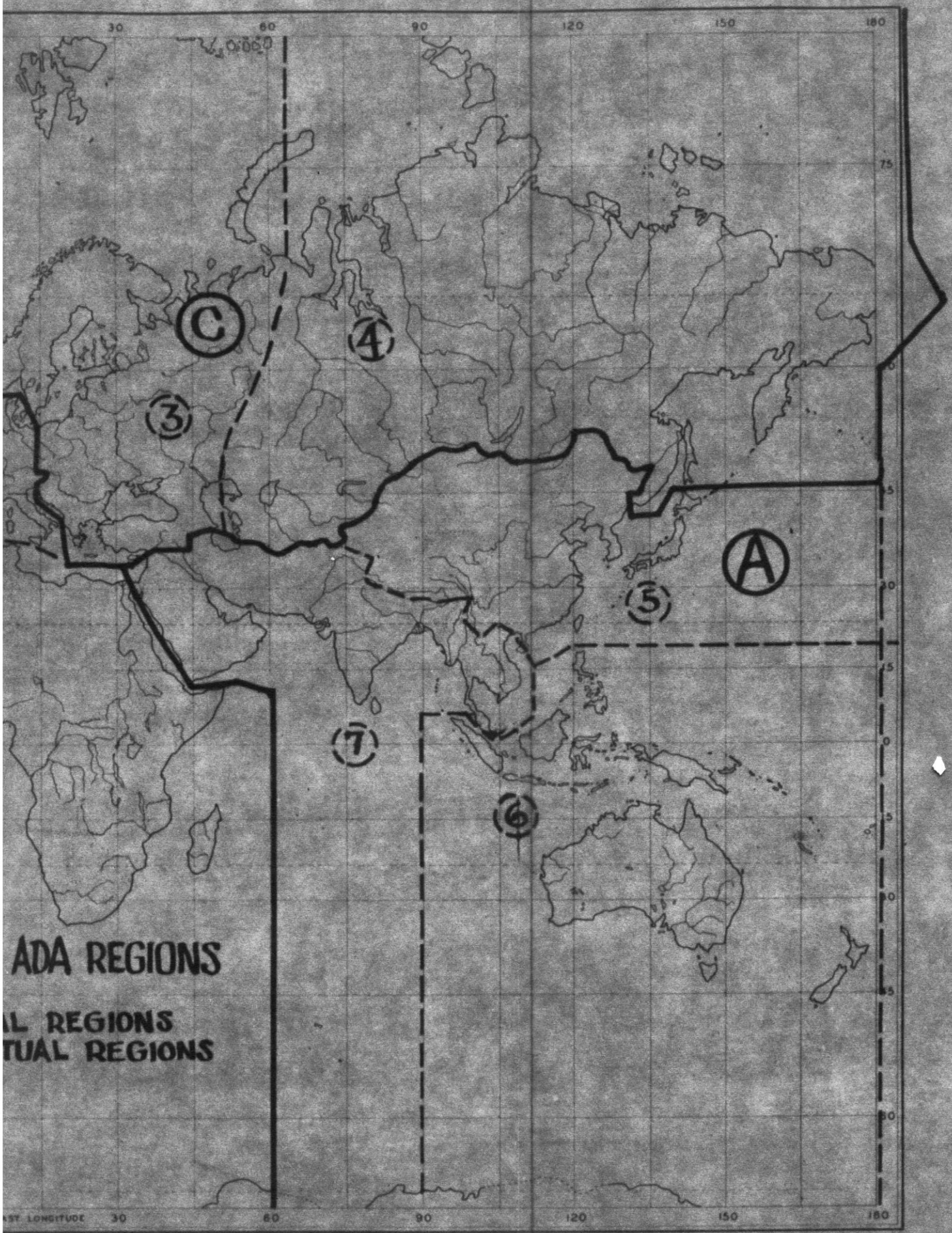
intermediate stages of industrialization prior to the stage where primary piles could be utilized. Mining areas remote from other power sources can make use of secondary piles. The trend of regional migration of centers of mineral production away from Europe and U.S.A. described by Dr. Hogbom, suggests that secondary piles may become in the mining and processing of minerals in Asia and Africa. Processing of light metals such as aluminum and magnesium requires large amounts of electric power and may be developed in Asia by use of secondary piles.

7. Summary.

If an International Atomic Development Authority is established, it is probable that the major industrial powers would get the first primary piles. Such an allocation could be justified on political reasons to establish a balance of atomic power between the major powers, or on economic reasons because the major industrial powers are still increasing degree of industrialization, or require more electric power to maintain their degree of industrialization with population increases, or confronted with rising costs of present fuels. Next the smaller industrial powers would have a chance to build primary piles, followed by the introduction of secondary piles in heavily populated countries in the early stages of industrialization. The establishment of secondary piles in Asia in the late sixties might expedite the industrialization of China and India upon a basis of mining and processing of light metals.


180
150
120
90
60
30
75
60
45
30
15
0
15
30
45
60
(2)
B
(1)
A
(9)
EQUATORIAL SCALE
0 1000 2000 3000 MILES
0 1000 2000 3000 4000 KILOMETERS
180
150
120
90
60
30

6159-C


30
60
90
120
150
180
75
0
5
10
15
0
5
10
15
30
C
4
3
A
5
7
6
ADA REGIONS
L REGIONS
TUAL REGIONS
ST. LONGITUDE
30
60
90
120
150
180

If no Atomic Development Authority or equivalent international agreement is established, the location of primary piles could become primarily a military problem in an armament race.

APPENDIX A - Supplementary Data on World Power Production

NOTE:
For tabulated data see original copy of this paper.
References are listed, but not quoted, in this copy of Appendix A.

List of References

World Power Conference, Statistical Year Book 1933/1944.

Economist, (various issues 1945-1947)

Business Week, (various issues 1945-1947)

Canada Year Book

Electrical Engineering
May 1946, p. 196.
April 1947, p. 417.
Jan. 1947, pp. 66-74.

Electrical World
Jan. 18, 1947, pp. 135-156.

Academia Nauk, Electric Power Development in the U.S.S.R., Moscow-1936.

P.G.&E. Co., P. G. & E. Progress, XXIV, No. 5, April 1947.

* Atlas of Power Resources of the U.S.S.R., 1933-1935, (In Russian)

* "Power expansion planned in France," For Comm. W. 25:30, D14, 46.

Electrical West, 97:67-9 0'46

* Elec. R. (Lond) 139:687, N 1' 46; 139:726, N15,46

* Engineering, 162:449-50, N '8'46

* Electrician, 137:1146, 0'25,46

Gaffert Steam Power Stations, 3rd ed., McGraw-Hill Book Co. 1946, p. 2.

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* Reference not directly used in this report, but possibly useful in making more precise estimates.

APPENDIX B - NOTES ON INTERACTION BETWEEN PHYSICAL AND SOCIAL SCIENCES:

(Material requiring further evaluation as to validity and significance.)

The continued advance of science and the social use of specialization and a synthesis of the work of the specialists. Western civilization has produced many specialists capable of analysing problems in narrow fields, but difficulties have been encountered in developing a synthesis.

The Economics 291 seminar this semester has approached the problems of synthesis by direct discussion between specialists in different fields. This is similar to the procedure used in the T.V.A. and appears to be the only type of procedure suitable for immediate use. One might consider the present procedure as an empirical process. Perhaps some attention should be given at the appropriate time to developing a "working hypothesis" which would facilitate more powerful techniques of cooperation.

The material which I included in my report was chosen to emphasize a continual change with time and incompleteness of any one analysis or approach, in an attempt to avoid contributing to the establishment of some new orthodoxy. Mathematical methods of solution of differential equations by successive approximations may be used to get a sense of direction, but not be wrongly used as some early sociologists attempted to apply the laws of physics to social phenomena without indicating a reasonable method of verification.

The following characterizations of the meaning of truth at three stages of Western civilization as stated by Rosenstock-Huessy suggest some ideas.

"Truth is divine and has been divinely revealed.

"Truth is pure and can be scientifically stated.

"Truth is vital and must be socially represented.

However there are some ideas in his writings that appear quite confused.

Lewis Mumford has perhaps overemphasized the extent to which the unbalance between development in the physical and social sciences can be corrected by social control of schools and by waiting for a genius.

From Values for Survival:

> p 122 .....(society).....it would endow Schools of the Humanities and curtail Schools of Technology.
>
> p 123 "This age is still waiting for its new Bacon, who will re-write the Advancement of Learning with the human elements, which Bacon did not in fact exclude, in a dominant rather than a subordinate position.

According to K.K. Paulev[1] of General Electric Co., the probability of a genius occurring in a generation is quite small. We may have to rely upon bringing together numerous individuals who together form a "collective genius" to solve many of our problems.

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[1] General Electric Rev. May 1941, pp. 254-261.

The Humanist, April 1945, pp. 1-7.

W. I. Vernadsky of the Academy of Sciences, U.S.S.R. has given the following to think about:

> The geological evolutionary process shows the biological unity and equality of all man, Homo sapiens and his ancestors, Sinanthropus and others; their progeny in the mixed white, red, yellow, and black races evolves ceaselessly in innumerable generations. This is a law of nature. In a historical contest, as for instance in a war of such magnitude as the present one, he finally wins who follows that law. One cannot oppose with impunity the principle of the unity of all men as a law of nature. I use here the phrase "law of nature" as this term is used more and more in the physical and chemical sciences, in the sense of an empirical generalization established with precision.
>
> The historical process is being radically changed under our very eyes. For the first time in the history of mankind the interests of the masses on the one hand, and the free thought of individuals on the other, determine the course of life of mankind and provide standards for men's ideas of justice. Mankind taken as a whole is becoming a mighty geological force. There arises the problem of the reconstruction of the biosphere in the interests of freely thinking humanity as a single totality. This new state of the biosphere, which we approach without our noticing it, is the noosphere.....[1]

Perhaps we need something more condensed, and yet more full of fundamental meaning than the typical encyclopaedia. The Encyclopaedia of Unified Science may be of considerable value along this line.

One phase needing attention is an interscience evaluating procedure by which a physical scientist may more easily check the relative merits of different points of view in sections of the social sciences where there is lack of

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1 "The biosphere and the noosphere," American Scientist, 33:1, Jan. 1945, pp. 5, 7-10.

agreement between the specialists.

There seems to be a lack of thorough discussion of atomic energy problems in American Marxist circles. Perhaps a new (or variation of some existing) socio-economic theory needs to be introduced as a catalyst to activate a vigorous discussion. Perhaps Sorokin's concept of "trustees of public property" could serve as a nucleus for such a development.

Another study that could be helpful to both objectives of the seminar would be a comparative study of Soviet ethics and Hebrew-Christian ethics. Some work along this line is being attempted by the Society for Religious Culture.

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