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NOTE on CONTRACT for supply of Electricity to Aluminium Industry

The following comments fall into four groups namely 1: Comments on principles relating to the duration of the contract and the form or structure of the tariff. 2: Comments on the magnitude of the tariff. 3: Detailed comments on certain of the terms of the contract. 4: Arguments which can be advanced for asking that the contract be set aside and the whole situation re-examined.

I. Comments on Duration and Tariff Structure

1. 1. Length of Contract

It is a fundamental mistake to enter into a contract for a period of 50 years (or, in fact, for any period exceeding, say, 10 years) without either (a) a "break" clause operating at, say, 10 year intervals, or (b) an automatic "built-in" price regulator enabling the price to be varied according to certain specified changes.

(a) A "break" clause would enable the contract to be revised at the request of either party at stated intervals on due notice being given. This is a safeguard to either party and by the same taken it involves a risk to both parties. But the maximum risk to the P.P.C. would be that a certain amount of generating plant would have been provided earlier than was necessitated by the normal load growth and that a small amount of transmission equipment would be wasted.

(b) A price variation clause would enable the price charged for the electricity to be regulated according to changes in other quantities such as the price of fuel, the rates of wages, the cost of living or the value of the Drachma.

It is sometimes thought that in the case of a hydro-electric project the protection afforded by either (a) or (b) is unnecessary. It is argued that, once the necessary finance has been provided on a fixed-interest basis and the construction work completed, no appreciable addition to the costs can arise in the future.

This argument is fallacious because the value of electricity or of any other service or commodity must be measured at any time by its value in real terms not in Drachmae. Similarly its cost must be taken as the cost at that time of replacing what is being consumed. It is impossible to foretell what will happen in the next 50 years but it has been an almost universal experience throughout the world that the value of money has fallen by at least 2 or 3 percent every year. At the present time the average selling price of electricity in Greece is approximately 10 times the price in the aluminium Contract. In 40 years time the Greek citizen might be paying (in terms of Drachma) several

times as much as at present and the aluminium might be worth several times as much and yet the aluminium company would be paying just the same for their electricity as now. This would represent an intolerable situation which would almost certainly be swept aside by public pressure whatever the legal position.

It is popularly supposed that whereas coal or lignite are "wasting assets" a hydro-station renews itself in perpetuity. This, however, is only partially true when viewed in the context of a steadily growing electricity load. Even countries which are exceptionally well endowed with potential hydro resources once thought to be well nigh inexhaustible, are now finding that all the really favourable sites have been fully exploited and that additional loads have to be met by developing sites at much higher capital costs.

1. 2.Structure of Tariff:

The tariff takes the form of a flat rate per unit of energy (kWh). This is wrong, in principle, particularly for a hydro-electric project in which only a negligible fraction of the costs are related to the kWh. It is true that if the load factor (that is the ratio of kWh to kW of maximum demand) is constant, as is likely to be the case with aluminum production, a price per kWh represents a price per kW but this is beside the point. The proper purpose of the electricity tariff is to relate the price to the cost in a rigid and precise manner independent of the behaviour of the customer or the processes of manufacture. It should be fool-proof and "time-proof" and not merely based on what seems "likely" at the present.

The P.P.C. has no direct knowledge of and no control over the processes employed by their customers. In 30 years time the aluminum Company might have a different process, operating at half their present load factor. They would then be able to buy kW of maximum demand for one-half of the present price.

Summing up, the one element that is absolutely essential in a tariff governing the supplies from a hydro-electric station is the one element which the present tariff lacks, namely a kilowatt charge. There can be few, if any, comparable examples throughout the world of such an omission.

Ideally, and in equity, the tariff should consist of the sum of three items, namely:

a) An annual kW charge based on the metered maximum demand during the year.

b) A kWh charge based on the metered consumption during the year.

c) A minimum annual charge irrespective of consumption.

The minimum (c) can take any one of several different forms. It can be attached to either (a) or (b) so that the customer pays either for a certain minimum demand or for a certain minimum of consumption. Whatever its form it must guarantee a certain minimum annual revenue to the P.P.C.

2. Comments on Magnitude of Tariff

2. 1. Price

Looked at from every conceivable angle the contract price for the aluminium supply is by any standard extremely low. The figures are as follows:

	mills/kWh	lepta/kWh
First 16 years	3.1	9.3
Subsequent years	3.6	10.8

The above figures can be most effectively criticised by setting out the figures that have been arrived at in a number of other calculations.

2. 2. Hypothetical Development of Kastraki for Aluminium Supply only

The following assumptions have been made in this estimate:

Capital cost with 3 - 80 MW sets	52.1 X 10^6 $		
Reduction for non-supply of 3rd set	5.4		
Cost with two sets only	46.7		
Taking 30 Drs. = 1 $ this equals	1401 X 10^6 Drs.		
Annual capital charges:			
Interest	6%	:	
Depreciation on 65 year life (6% tables)	0.139	:	10^6 Drs. per annum
Insurance	0.1	:	
Total	6.239%	:	87.3
Operation and maintenance at 0.36%		:	5.0
		:	92.3

Assuming a mean annual output of 800 X 10^6 kWh this gives a price of 11.54 lepta per kWh.

Adding 9% for transmission costs and losses, this becomes 12.58, say 12.6 lepta per kWh.

If all three sets were installed (giving full kilowatt stand-by and 860 X 10^6 kWh annual output) the cost would be 13.05 lepta per kWh.

In calculations such as the above which are based on the marginal costs of an isolated self-contained complex of station plus consumer, there is usually no provision for the following items:

Stand-by kW capacity. The firm capacity is limited by the installed capacity at the site minus the capacity of the largest of the sets in the event of breakdown.

Stand-by kWh capacity. Since the energy output of a particular hydro-station is limited by rainfall and site characteristics, the output in the worst drought conditions may limit the industry production.

Provision for load growth. If the power requirements increase, it is impossible to increase the kW capacity of an isolated hydro-station quickly if at all.

Management, overhead and common system costs. It must be realized that the economic development of a hydro site is conditioned by its physical characteristics. There may be alternative load factors for which it can be developed but usually the choice is not wide and once the choice has been made, it can rarely be changed. This rigidity is in contrast to a thermal system in which the sets can be and usually are run at high load factors in the early years of their life and progressively lower load factors thereafter. It follows that a mixed thermal and hydro sytem offers much the best way of getting the most out of the resources of a country like Greece which has both types of resources in considerable magnitudes. Isolated development would constitute a gross waste of investment resources, since it is highly unlikely that the characteristics of any generating station, whether hydro or thermal, will exactly and at all times match the requirements of a particular industry.

2. 3.Marginal Cost of Four New Projects.

An estimate on similar lines to the above was made two or three years ago in a document entitled "Note on the New Industrial Rate-Schedule". The rates of interest, method of depreciation provision and other such assumptions are the same as those given above for Kastraki alone. The results of the calculations are given in the following table:

Project	Capacity MW	Mean Annual Output 10^6kWh	Addition for Inter-connection	Generation Cost per kWh	
				mills	lepta
1. Kastraki	240	880	9%	4.3	12.9
2. Kremasta	400	1600	9%	3.24	9.72
3. Ptolemais II & III	250	1800	9%	5.55	16.6
4. Megalopolis I & II	250	1800	9%	5.45	16.3
5. Combination of all four	1140	6080	12%	4.86	14.6

In the writer's opinion these figures are totally unrealistic and in fact have no real meaning. The implication of lines 1 and 2 of the above table are that if Kastraki or Kremasta could be developed solely for an aluminium industry located close to this they would be able to supply energy to it at prices in the range 10 - 13 lepta. This is not correct. The price in line 1 is for a supply at less than half the load factor of the aluminium industry. The only way of exploiting Kastraki efficiently would be to connect it up to other loads as well. The price in line 2 is even farther from the mark since this is the figure for the output from a 400 MW station.

The only possible way in which these four stations could be operated economically and efficiently is as part of an interconnected electricity system, and that in fact is how it is proposed that they will be used. Their operation in conjunction with an aluminium industry as isolated self-contained systems would be uneconomical. Since they are not in fact to be so operated, any calculations based on such an assumption are irrelevant.

In fact they will be supplying energy not to an aluminium works but to the P.P.C. system, and the aluminium industry will be buying electricity not from a hydro station but from the P.P.C. system. These are the physical facts of the situation, and the tariff must correspond to these facts and not to some imaginary concept.

The above fact is implicitly admitted in the terms of the Contract which refer to supplies being assured through employment of the general network. In fact the Contract terms appear to be aimed at securing the economic advantages of living on an island with the security and amenities obtainable on the mainland; an insurance is required but without the payment of any insurance premiums.

2. 4.Comparison with American Contracts

The Greek Contract price may be compared with the price under contracts given by the Tennessee Valley Authority (T.V.A.) in the USA to the Reynolds Metals Company for their aluminium reduction plant. Under a typical contract the price was as follows: $14.40 = 432 Drachmae per annum per kW of maximum demand plus 2.5 mills = 7.5 lepta per kWh.

At the mean annual load factor expected with the Greek aluminium project, this would be equivalent to an overall price of 13.2 lepta which is nearly one and a half times as much as the Greek Contract. Moreover the T.V.A. is one of the largest and most economical supply groups in the world whose mean costs per kilowatt hour are only a small fraction of the mean costs of supply in Greece.

This agreement is only for a period of 12 years from the time it was first made and is then renewable for sucessive periods of 10 years. Moreover, even during these periods the energy charge is automatically varied according to changes in the fuel cost and both the energy and

the demand charges are increased if the taxes, etc., levied on the supply authority are increased. This flexible tariff contrasts strongly with the rigidity of the Greek tariff.

2. 5.Comparison with Cost Formula "A".

A year ago a complete cost analysis was made ralating to the conditions forecast for 1966 for use as a basis of tariff recommendations. The figures were given in the "Interim Report on Electricity Tariffs" compiled by the writer and submitted by Consulting Engineers Kennedy and Donkin in August 1963. For this purpose the system was sectionalized into three, the first of which (Point "A") covered the cost of generation and high tension interconnection and transmission. This carried the costs down to approximately the point at which the aluminium supply could be regarded as being taken. It involved slightly greater transmission cost than would be necessitated if a single station supplied a single industry in the vicinity. (The addition to the generation cost on this account was 14% at Point "A" as compared with the 9% assumed above).

Under the 1966 Cost Formula "A" (Table 18, p.35 of Interim Report) the price for the aluminium supply would be as follows:

110 MW at 1327 Drs. p.a. per KW	= 146.0 X 10^6 Drs.
830 X 10^6 KWh at 11.08 lepta per kWh	= 91.9
Total	237.9

Mean price = 237.9/830 Drs. = 28.6 lepta per kWh

This is 2.2 times as much as the hypothetical cost figure of 13 lepta and approximately 3 times the initial contract price of 9.3 lepta. The following are the main factors which account for the difference.

2.5.1. The cost formula is based on the budget forecast for 1966, this being the target year at which the new tariffs are aimed. The total "yield" or "return" on capital (including both interest and depreciation provision) which is provided for in the budget is made up as follows:

Interest yield (bottom of p.31)	6.315%
Depreciation rate on hydro plant 1/65	= 1.538
	7.853

This is 1.28 times the figure of 6.139% used in the hypothetical cost calculation.

N.B. The above figures are expressed as percentages of the first cost of the assets. Thus the interest rate would be a higher figure if expressed per cent of the net capital.

2.5.2. The cost formula "A" expresses the average cost of generation over the whole of the Corporation's generating stations as at 1966, both thermal and hydro, whereas the hypothetical calculation gives the marginal cost of a particular, highly-economical addition, to the generating capacity. Even so, it is probably only the short-term marginal cost and does not cover the cost at which the assets which are being exploited could be replaced.

2.5.3. The cost formula A includes an allocated share (up to the HT supply points) of the following items.

a) Management (3.6%, Table 12)
b) Costs of general utility assets (4% addition, Table 16)
c) Higher costs of diesel operation (representing 5.4% addition)

2.5.4. In the cost formula A the cost of H.T. transmission and interconnection is represented by the figure of 250.1 in the 6th line of Table 17 as a proportion of 1793.4 which is the sub-total of the first 5 lines in the same column. This adds 14% to the generation cost, whereas the figure used in the hypothetical calculation was only 9%.

2.5.5. In round figures the combined effect of the above factors can be expressed by the following cost multiplication ratios:

(Factor 1) 1.3 X (Factor 2) 1.4 X (Factor 3 and 4) 1.2 = 2.2

The underlying difference between the bases of the two calculations is that the cost formula refers to a nation-wide electricity supply system providing reliability and continuity. It gives a yield on the capital investment sufficient not only to enable the Corporation to continue to operate on its present scale ad infinitum but also to contribute an element of "self-financing" towards expanding developments.

2.6. Practical Considerations

From the purely practical and political point of view, it is unlikely that figures so high as those of cost formula "A" would attract large-scale industries into the country. Assuming that it was deemed desirable to attract such industries, it is therefore a question of how much below these figures it would be permissible to go. The principles underlying the answer to this question are firstly that the price should not be so low as to involve an actual loss on the additional load. Secondly, it should give a yield on the capital employed which satisfies both P.P.C. and the Government. This need not be so high as the "yield" employed in the 1966 forecast and the cost formulae derived therefrom, since this includes an element of "self-financing" which could be foregone in the case of particularly desirable

enterprises. In the third place, it should contribute something to the management and overhead costs, use of general utility plant, etc. This might be somewhat less than that included in the cost formula and in particular it might be absolved from any contribution to the cost of tariff unification throughout the mainland and the islands.

It is very difficult to embody the above principles in actual figures, particularly as regards the second one which is critical to the cost calculation and is very much a matter of national policy. It could be tentatively suggested that unless there are other considerations than those named, tariff values should not be offered of less than 70% of the above formula. This would represent an overall price of 20 lepta per kWh or just under 7 mills for the aluminium supply.

Care must be taken against dealing with individual cases in vacuo and without regard to the effect on the general situation. It must be realized that every special offer is a precedent and may lead to a demand for similar terms from others. Since the Corporation as a whole is required to pay its way, any special concession to one consumer has to be paid for by the remaining consumers.

3. Comments on Terms of Contract

(the following page and paragraph references refer to the French translation of the Contract).

General Comments:

Many of the clauses are ambiguous, with the quantities not precisely defined and some of them appear to be downright unenforceable. Substantial sums of money are made to depend upon data which is only available to one of the two of the parties concerned and there is almost endless scope for disagreement which might require arbitration or even litigation.

Page 2, par. 3

It is stated that in case of a change by the Society in the characteristics of utilization, they are required to reimburse P.P.C. for the additional financial charges. It would seem that these charges would be difficult to calculate and almost impossible to verify.

Page 3, par. 5

In the event of the demand being more than 5% in excess of the subscribed figure, "the energy corresponding to the excess power" shall be paid for at a specified rate. The energy corresponding to a certain power is not a specific figure and must be defined precisely if the clause is to be operated. Energy equals power multiplied by time, and the clause is useless unless a figure is given for the number of hours per annum of use.

Page 4, par. 1

If the excess demand causes "disturbances" (Query translation: French word "anomalies") in the P.P.C. network, the P.P.C. can call upon the Society to reduce its demand without delay and if necessary to interrupt the supply. In this event the energy not utilized by the Society as a result of the interruption would not be deducted from the minimum consumption guarantee. It is difficult to see how the limiting extent of disturbance could be defined and it is quite impossible to measure the quantity of electricity not utilized as a result of interruption.

Page 7, par. 4

This presentation is unnecessarily complicated and it would be simpler to speak of 81% instead of 90% of 90%.

Page 7, par. 6

This provides that if energy not consumed by the Society and thus affecting their minimum payments is sold by the P.P.C. to other consumers, the energy thus sold shall be deducted from the minimum guarantee. It is impossible to indentify either the source or the destination of an individual kilowatt-hour and thus to make regulations governed by the disposal of particular blocks of energy. In point of fact "the energy not consumed by the Society" would not be sold to anyone but would simply not exist. The P.P.C. would merely generate that much less energy.

Page 8, par. 2

It is provided that in the event of the French production group reducing production on account of a world crisis in aluminium production, the revenue guarantee to the P.P.C. shall be reduced proportionately. This is an outrageous requirement. In the first place it is necessary to decide how big a trade fluctuation must be before it can be described as a "crisis". In the second place, one has to investigate the operations of another organization working in another country, and in the third place, to decide not only what they are doing but what are their reasons for doing so. The contract is between P.P.C. and the Society and it is totally unreasonable to expect the P.P.C. to take on responsibilities for the actions of third and fourth parties of whom they have no direct knowledge and over whom they have not the slightest control.

Page 10, par. 6

It is provided that after the Aluminium Company has paid all its own costs and charges together with 8% dividend on its shares, it will give to the P.P.C. 15% of the remaining surplus. Having regard

for the fact that this surplus only arises because of the very low electricity price the repayment of only 15% is so small as to be almost insulting. Moreover, the carrying out of this clause would involve employing accountants to examine the books and would be very difficult to execute.

4. Reasons which can be advanced for asking for a revision of the Contract.

4.1 The estimates of project costs for the new stations which are to be constructed have already had to be revised upwards. In view of continuing rises in prices and rates of pay it is highly probable that when the stations come to be built the actual costs of construction will prove to be higher still.

4.2 The figures of electricity requirements per ton of product which were used in order to establish the necessity for a low price for electricity now appear to be inaccurate. There is strong reason to believe that the actual consumption per ton of aluminium will not be higher than 80% of the figure quoted in the negotiations.

4.3 The maintenance of a fixed price in Drachma for electricity for a period of 50 years independent of changes in the value of Drachma, the price of aluminium, or the cost of other materials and services is totally inequitable. It would hardly be acceptable by any government in the world at the present time and is unlikely to continue indefinitely to be accepted by the Greek population.

4.4 Several of the clauses of the Contract are so worded as to be ambiguous and cannot be enforced until they have been clarified and made precise. This applies particularly to the clauses detailed in Section 3 of this Note.

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20.5.1964