MKG－TEC－005

Sambor Project Report 作成についての

技術上の往復文書

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1. Report の提出期限に関する文書

September 12, 1968

MP/A. 967
TEC 322 (3-2)
ORG 310 (1)

My dear Dr. Aki,

During discussions of the Advisory Board meeting on the progress of the Sambor project when I brought to the notice of the Board that the final report of the Sambor project is expected by March 1969, Mr. G. Suzuki commented that he had heard in Tokyo from the OTCA that the final report of Sambor project will be delayed until August 1969.

I would like to inform you that the 12th meeting of the Advisory Board is scheduled to be held at Bangkok from 1 - 10 September 1969. It is necessary that the final report of the Sambor is sent to the Board members at least one month in advance to enable them to study the report before they come to the meeting. I would, therefore, request that every effort be made to send me at least 12 copies of the final report, not later than the third week of July 1969.

I shall be obliged if you would kindly confirm this date.

With my best regards,

Yours sincerely,

Kanwar Sain
Director of Engineering
Services

（ECAFEよりの資料送付に関する文書）

September 18, 1968

MP/A. 1003
TEC 322 (3-2)

Dear Dr. Aki,

Subject: Sambor Project-Reservoir Operation with Flow Regulation of Nam Ngum and Pa Mong Reservoirs

As promised during the discussions of the Sambor Draft Report, I have pleasure in forwarding herewith 2 copies of the studies carried out by us on the above operation. I am sending only one copy of Annexes 1 & 2 ; I understand that one copy of these Annexes was handed over to you by Mr. P. T. Tan when you passed through Bangkok in the first week of September.

As you will see from these studies, the Nam Ngum and Pa Mong releases increase the power output of Sambor very appreciably. You will also notice that the development of irrigation from Pa Mong to the extent of one million hectares reduces the firm power at Sambor from 1,117 MW to 1,098 MW.

If there are any further queries in connection with the above studies, we shall be happy to give you additional information.

Please note that the studies carried out by USBR MC19-MC20 are restricted in scope; the studies carried out by the Mekong Secretariat are more comprehensive as these include the secondary energy and have taken into account the effect of varying tail water and varying turbine efficiency.

Yours sincerely,

Kawar Sain
Director of Engineering Services

（USBRよりの資料送付に関する文書）

August 16, 1968

Dr. Koichi Aki
Advisor
Overseas Technical Cooperation Agency
#42 Homura Cho
Ichigaya, Shinjuku-ku
Tokyo, Japan

Dear Dr. Aki:

At the recently concluded informal discussions on the Sambor Project Draft Report you requested data on operation studies for the proposed reservoirs of the Pa Mong Project, Laos-Thailand. In response to this request, we are sending under separate cover one (1) copy each of Reservoir Operations Studies No. MC-19, and No. MC-20.

Study No. MC-19 assumes an irrigation release to 30,000 hectares (possible stage 1 development) and study No. MC-20 assumes an irrigation release to 340,000 hectares (estimated 15 years irrigation development).

The small difference in hydro-electric generation between the two studies indicates the relatively minor effect that irrigation development will have on power production.

The area and capacity curves previously sent to you (Dwgs. T5-B-6.27, T5-B-b.28 and T5-B-6.39) of Nam Mong, Nam Lik and Pa Mong (Lower Damsite) are are still the best data available and will remain so until new reservoir topography is obtained. It appears that this topography will not be available for our Phase II Studies.

These studies and curves are the basis for our present water resources development planning, and will be used in the Pa Mong Project, Phase II, 1968 Interim Report.

Sincerely,

N. H. Tippets
Acting Project Engineer
USBR Project

2. 1968年7月に行なわれたDiscussionのメモ

D R A F T (Rev.)
17 July 1968

SUMMARY MINUTES OF INFORMAL DISCUSSIONS ON SAMBOR PROJECT DRAFT REPORT
(Monday 8 to Thursday 18 July 1968)

Informal discussions on Sambor Project Draft Report, presented by the Japanese Team, were held at Bangkok from Monday 8 to Friday 12 July 1968; the list of participants is enclosed as Annex "A". The opening session at Bangkok was chaired by Dr. C. Hart Schaaf; all other sessions were chaired by Mr. Kanwar Sain.

Informal discussions were continued at Phnom Penh from Monday 15 to Thursday 18 July 1968; the list of participants at Phnom Penh is enclosed as Annex "B". The meetings at Phnom Penh were chaired by Mr. Khy Taing Lim. throughout.

The Japanese Team prepared the Sambor Project Draft Report in four volumes:-

Volume I	:	General Report
Volume II	:	Dam, Power, Transmission, Sub-stations & Power Market
Volume III	:	Irrigation and Agriculture
Volume IV	:	Navigation

Volume I and Volume II had been translated into English and a limited number of copies were available a few days in advance; Volume III and Volume IV were available only in Japanese and have not yet been translated.

Cambodian delegates, the USBR team and the members of the Mekong Secretariat congratulated Dr. Aki and his team for the thorough investigations they had carried out during the last seven years for the

preparation of the report. The feasibility report, presented in four volumes, was very impressive. Cambodia & the Secretariat was grateful for having had the opportunity to have informal discussions with the Sambor team so that each other's points of view could be clarified. Certain points were brought by the participants to the notice of the final report. These points are briefly mentioned below.

Statistics (Chapter 2)

It was pointed out that while the Sambor team had used the figures published in ECAFE Survey of 1965 which had been used in the 1966 UN Statistical Year Book, the figures could be updated by using the ECAFE Survey of 1966 from which the figures had been taken in the 1967 UN Statistical Year Book which has come out only recently. The Mekong Statistical Bulletin is based on the latest figures available as well as national resources.

Comments on individual sections as below:-

Table 2-1 : No major comment.
Revision suggested : Laos population 2,635 thousands instead of 2,000. See UN Monthly Bulletin of Statistics, any recent issue. The density accordingly becomes 11 instead of 8. (Note : Viet-Nam area of 170,806 is subject of revision, but may not be altered in the table).

Table 2-2 : The figures given here are from the 1966 UN Statistical Year Book. A number of the figures there are provisional. For example, Cambodia maize should be 139 instead of 210. Revised figures in those cases can be had by using the 1967 UN Statistical Year Book. The Mekong Statistical Bulletin which has been updated by reference to national sources may also be used with same result. (If the UN Statistical Year Book figures are used, the words "Sn content" should be added to "Tin concentrates".

Energy figures on page 2-16 : The source of the figures in the first part of the paragraph is not mentioned. Compared with the figures in UN Statistical Year Book and the Mekong Statistical Bulletin, the KW figure for Cambodia should be 37,000 instead of 30,875 and for Viet-Nam 116,000 instead of 203,202.

Table 2-3 : As in the case of Table 2-2, by using the 1967 UN Statistical Year Book, or the Mekong Statistical Bulletin, a revised series could be obtained.

The term "Unhulled or cleaned rice" may be changed to "rice, rough or paddy."

Table 2-4 : The last figure in column 4 should be 33 instead of 23.

In general, slightly revised figures could be obtained by using the 1967 UN Statistical Year Book. (The Mekong Statistical Bulletin gives the figures in national currencies instead of dollars).

Table 2-5 : A foot-note that for Cambodia it is GCP and GNP, is necessary, as given in the original source. The exchange rates used for conversion to dollars may be also shown. (The Mekong Statistical Bulletin gives the figures in national currencies).

Table 2-6 : It is not clear whether the change of Base year had been adjusted for, in the Laos series, beginning 1962. The Thailand series appears to be based on 1962 = 100 rather than 1958 = 100.

Minereal Resources (page 2-12)

The map appears to be somewhat incomplete. The deposits are not very accurately located; for example, there are no

tin or lead deposits along the Mekong near Luang Prabang; while other occurrances that exist are not shown; perphas could be reviewed in this respect.

Hydrology and Water Resources
(Chapter 2 - para. 2.12, page 2-5, 2-6)

(1) Description on annual rainfall over the basin given in page 2-6 should be re-checked. The amount of rainfall in the Mekong Plain, Korat Plateau and Grand Lac is somewhat more than 1,000mm, not less than 1,000mm as stated in the Report.

(2) The river stage at the damsite begins to recede by October and not by December as stated in the Report, page 2-6.

(3) Fig. 2-6 showing hydrographs of the Mekong River stages should indicate also whether its water levels is expressed in terms of gauge reading or M.S.L.

Chapter 4 - para. 4.2.1., page 4-2

(4) The purpose of Sambor Project, as stated in the Report, is to decrease the damage of flood. This should be delted, because the control structure does not give considerable storage.

(5) Statement on irrigation given in page 4-3 should be modified as to what are to be under direct command of Sambor Project so that one may clearly visualize the benefit stated.

(Chapter 5 - para. 5.1, pages 5-1, 5-2)

(6) Floods which occur during August to September in the Lower Mekong are not only outcome of the Inter-tropical Convergence Zone alone as

stated, but also of the Tropical Cyclonic Storm in the forms of Typhons and Depressions.

(7) Description of temperature should be presented in degree term from lowest to highest instead of its range of fluctuation.

(8) Evaporation description given in page 5-2 indicates lowest in April and highest in August. This statement must be reversed. The term "below 6mm per day" for evaporation should be re-checked, and the average value may be used instead. The report discusses that no remarkable difference of monthly evaporation between the wet and the dry seasons is observed. This statement may be subject to improvement as the evaporation during dry month is twice that of the wet month, i.e. 81mm in September against 162mm in April, see Table 5-4 in page 5-11.

(9) Fig. 5-1, page 5-3 should be presented in bar-scale.
(para 5.2.1, page 5-4)

(10) The estimated flow data at Kratie, available at the Secretariat, were based on flow correlated from Stung Trong, and not specific runoff at Kratie as stated in the Report.

(11) Flow data at Kratie (1933 - 1965) presented in Table 5-1 of page 5-5 may be improved by expanding data period back to 1924, so that power operation test can be made as long as 42 years. There are some minor deviations of flow data between those given in Table 5-1 and the revised flow data proposed by the Secretariat. The only significances worth mentioned are:-

(a) The maximum ever recorded flood of 73,600cms in 1940 in Table 5-1 will be replaced by the revised 64,000cms. The figure 73,600 is, therefore, no longer a maximum recorded, but the peak flow of 66,700 cms in 1939 in Table 5-1 would stand as the maximum ever recorded at

Kratie instead.

(b) The minimum dry season flow should have been at 1,250cms in 1960 instead of 1,160cms in 1933. The figure 1,160cms in 1933 will be replaced by the revised 1,480cms.

With the revision in flow data together with the extended record to 1924 as suggested, the Group felt that the project operation in the Report as far as power production is concerned, would not be materially affected.

(12) Statements concerning magitudes of flood and dry flows given on page 5-4 should, therefore, be corrected according to the revision made in item (11).

(13) Explanation in deriving the corresponding stages and flows at the damsite should be clearly made. The observation of water level at the damsite should be twice a day instead of twice a month as discussed in the last paragraph of page 5-4.

(14) Rating curve developed for Sambor damsite shown in Fig. 5-4 of page 5-7 should be verified as to how its extrapolation could be made to meet the design flood level of 25.6m. The over-bank flow assessment assumptions are desirable.

(Para. 5.2.2, page 5-4)

(15) The term "Groundwater" should be "Subsurface groundwater".

(16) The Report discusses that subsurface watertable becomes deeper when traversing downstream. This phenomenon should be re-checked as getting toward the delta the watertable should be nearer to the ground surface in general.

(Para. 5.2.3, page 5-6, page 5-9)

(17) The Report suggest that the probable maximum flood should be adopted for the spillway design flood as the dam is of the combination of earthfill and rockfill, but, somehow the 1000-year flood of 101,000cms has been employed. This implies that 1000-year flood is probable flood whereas 10,000-year flood of 118,000cms has also been posted. In general practice, 10,000-year flood has been rated as the maximum probable flood grade.

(18) The other approaches in arriving at the probable flood should be attempted for comparison. The enveloped curve flood technique and some other applications of regional flood parameters may be useful for comparative study. The Secretariat was invited to assist in solving the problem. A study by the Secretariat is requested and it should be ready in a week time.

(19) The inflow design flood hydrograph with its reservoir routed outflow flood hydrograph should also be presented in the report. The storage capacity and area curves of the reservoir and spillway rating curve are suggested to be included in the report.

(20) The statement in connexion with flood peak reduction through reservoir flood routing should be clearly made. The reduction of 12,000 cms out of the total inflow of 101,000cms is presumably made up by the flood surcharge of 2 meters above the retention level at 40m. The spillway design flood begins while the reservoir being at its retention.

(Para 5.2.4, pages 5-9 and 5-10)

(21) The suspended sediment concentration varying from zero to several hundreds of part per million as stated in the report should be checked up. It is hardly observed the zero concentration while the river is always in flowing condition.

(22) The concentration being a straight function as $C = 0.012\ Q$

mentioned in page 5-10 seems susceptible to question. The concentrations of flows during early monsoon season and those in the recession period are apparently different. In general, it is hardly necessary that the concentration would vary with the flow. In general practice, logarithmic correlation between the flow and sediment transportation expressed in tons per day is an approach used in developing sediment rating for assessment of total suspended sediment transportation. Some sediment study available in the Secretariat would be handed to the Team.

(23) Assumption of bed load estimation suggested in the Report as 15% of the suspended load may be opened to question. The percentage is subject to great variation as for some rivers in Thailand 75% may be expected.

(24) The sediment trapping percentage of 75% being assumed for Sambor reservoir seems relatively high as far as the runoff-river barrage type of dam and its typical fine sediment are concerned. The barrage will be operated under the all-opened condition during flood season when the river flow exceeds the power release. Therefore, effective evacuation of sediment is greatly expected.

(Para 5.3.3, page 5-15)

(25) According to the revised flow data, the minimum flows discused in the navigation paragraph should also be revised.

(Para 5.5.3, page 5-19)

(26) The probable minimum flow at the damsite to be expected in the future without upstream development should be anticipated in connexion with navigation and power operation of the project.

(27) Fig. 5-6 (2) on page 5-22 indicating reservoir operation would be improved with detailed explannation.

(Para. 7.6.3, page 7-23)

(28) The optimum height of the Sambor dam is stated to be under control of the future tail water level at Stung Treng power station. The flood magnitude adopted for backwater effect in this connexion should also be specified.

(Para. 7.6.6, page 7-31)

(29) According to the report, the spillway structure would be of 1,471m in width to discharge 89,000cms of the design outflow flood. The number of spillway gate proposed is 86 (15m). It was the Working Group suggestion that the desirability of an emergency-type of spillway should be kept in view so that the main spillway could be reduced to a service spillway of which the reduction in cost might be expected, taking into consideration also the long return period of the great flood and the inundation during the flood occurrence at some elevation of 24-25m.

Irrigation Aspects

The Cambodian representatives pointed out that the cost of development from the Sambor project worked out as 51,000 Riels per hectare and looks to be rather high.

The Japanese Team explained that this was due to half the area being irrigated from pumps. The cost of pumps had been included in the project. The entire irrigation area of 34,000 hectares was divided into 12 blocks; the internal rate of return on these blocks ranged from 2.9 to 7.6 per cent a year while the internal return on the whole area came to 4.5 per cent. If a certain amount of economy, if desired, could be obtained by omitting some of the blocks which showed a low percentage of return.

The Cambodian representatives pointed out that 17,000 hectares only out of 34,000 hectares was dependant for water on Sambor reservoir; this used only 238 million cubic metres out of 2.0 billion cubic metres of

life storage at Sambor. The Cambodian delegation wished to know whether additional area could be brought under irrigation from the Sambor project. The Japanese Team & Secretariat explained that while water would suffice for irrigating about 140,000 hectares, the topography of the area was such that gravity flow irrigation had to be limited to small area of 17,000 hectares only. On subsequent occasions, it should be possible to extend irrigation by pumping, investigation of such projects will have to be undertaken separately.

It was pointed out that overall efficiency of irrigation of paddy in the region appeared to be too high. Should the irrigation efficiency be lower than assumed in the project, the water requirements may be larger than 43.9 cumsec.

Fisheries Aspects (page 5-16)

The project report does not take due cognizance of the magnitude of impact of the dam on the fisheries of Mekong and its tributaries. Sambor dam would be located across the principal route of migration of commercially important species of fishes, to the upper stretches of the river (i.e. between Sambor and Pa Mong). Further, the dam is likely to bar access to the spawning grounds of valuable species of fish which contribute considerably to the fisheries in the Great Lake and deltaic region. Unless adequate studies are initiated to elucidate these problems and provision made for ameliorative measures, there could be a catastrophic loss to fisheries in a wide area of the basin.

In tropical rivers, such as the Mekong, which are subject to annual monsoon regime, extensive fish migration, over several hundreds of miles, take place during the flood season for purposes of breeding, feeding or species dispersal. Such migrations are exceedingly important in that they repopulate sections of rivers which during the dry months become practicly denuded of fish life due to unfavourable enviromental conditions. Such a repopulation is highly advantageous, from a human point of view, in that it, incidentally, contributes to a lucrative fishery in the areas concerned

providing employment and valuable protein food to the riparian people.

In the Mekong, extensive fish migrations are reported to occur, albeit on insufficiently documented evidence. Important among such long range migrante, which presumably pass through the Sambor dam site from the lower stretches of the river to the upper stretches (between Luang Prabang and Sambor) are :-

1. Cirrhinus auratus
2. Probarbus julieni
3. Cirrhinus julieni
4. Pangasius sutchi
5. Pangasianodon gigas
6. Thinnichthys thinnoides
7. Pangasius sanitwongsei
8. Hilsa ilisha

All the above species are commercially very important and contribute considerably to the fish catches both in the upper (above Sambor) and lower sections of the river. Hence, the all important question whether these fish really migrate through the Sambor dam site and Khone falls has to be answered at a very early date, if we are to halt a calamitous decline in the fishery of these species in Laos and Thailand. The answer to the question may be in the affirmative, confirming the belief in which case adequate measures, not necessarily, but not excluding the provision of passage facilities, have to be planned and executed. If on the other hand, investigations reveal the existance of a natural barrier to fish migration in Khone falls and show that the members of identical species above and below the falls are discreet local stocks, no specific measures would be necessary.

A second, equally important aspect of Sambor development which would have a profound impact on the fisheries of the section of the Mekong below the dam site, the Bassac, the Tonle Sap and the Great Lake, is the reported location of the spawning grounds of :-

1. Cirrhinus auratus

2. Pangasisus spp

3. Pseudosciaena sp

above the dam site, in the stretch of the river between the Khone falls and Sambor. If this is the only spawning area for the species in the watershed, it is imperative that adequate protection measures are planned in time. This problem assumes great importance in view of the fact that these species are among the most highly prized food fishes in Cambodia and Vietnam, where they contribute to lucrative fisheries.

Thus, the two problems mentioned above are two of the most important fishery problems of Mekong development which have to be taken up for immediate investigation. Such investigation will provide the necessary information for planning measures calculated to off-set a serious decline in fish production, probably in a wide area of the basin.

The Cambodian delegation attached considerable importance to ensuring that fish production was not affected in any manner. They emphasized that not only the necessity of carrying out immediate investigations but also that showing the fish ladder be clearly remarked in the present design layout and making necessary provision for the cost of the fish ladder in the project estimate. The detailed design of the fish ladder could be prepared in the preconstruction design stage after further investigations have been carried out; such investigations should be carried out jointly by the Japanese Team, the Mekong Committee, and the Fishery Department of Cambodia.

Legal Aspects (page 5-4)

Messrs. D. Caponera and B.J. Wolhwend had prepared a comprehensive note showing the present position regarding national and international low pertaining to navigation and other uses of water. In case a copy of this note has not already been supplied to the Japanese Sambor Team the Secretariat would furnish two copies of this note in English and

French for such reference in the final report of Sambor project as they may choose to do so.

Power Aspects

1. Assessment of future power demand in the area to be served by Sambor project (Cambodia and Republic of Viet-Nam):-

It was reiterated that the assessment made by the Sambor Team and the Mekong Secretariat was surprisingly very close to each other for years 1988 onwards, but for earlier years the assessment made by the Sambor Team for Viet Nam was less than that made by the Mekong Secretariat. Copies of the assessment made by the Secretariat were handed over to the Sambor Team for such use as they can make. Cambodian delegation thought that the forecast was too optimistic.

2. The Sambor Team has assumed that only 60 percent of the additional demand in the area to be served by the Sambor project would be met by the Sambor project and the balance of the demand is to be not by national multipurpose or other power projects. It was brought to the notice of the Sambor Team that ordinarily all demands for power before the Sambor project comes into operation would be met by national projects and after the Sambor project comes into operation all demands should be met by the Sambor project until its potential is exhausted. Such a plan of development would be most economical to the countries concerned with regards to financing of the project and the project would have better internal rate of return due to more rapid utilisation of power potential. However, if some national multipurpose projects were decided to be implemented simultaneously with the Sambor project (which as far as can be seen is not likely to be the case) perhaps allowance of 10 per cent of the demand to be met by such projects would be more realistic against 40 percent now assumed. The Sambor Team promised to re-examine this question. The Cambodian delegation pointed out that Table 7-11 was already out of date and needed to be revised.

3. Firm capacity : From the records of availability of water indicated in the draft report, it was seen that the firm capacity of the project was less than what had been indicated in the draft project report. It was explained by the Sambor Team that the hydrological record of 1935 was made available to the Team after the study was completed and as the shortage was only in one year out of 33 years, it had been ignored. The Team promised to re-examine the question and adopt the firm power capacity on the basis of international standard.

4. Size of generating units : The subject was discussed at considerable length and it was not possible to obtain from the Sambor Team clear explanation for adoption of the particular type of turbine for connecting 125 MW generator at the initial stage and later 200MW generator. The Team promised to re-examine this question and furnish a detailed explanatory note to the Secretariat and also furnish adequate information in the report so that the project report would be completed.

It was also pointed out to the Team that the draw down of the reservoir was stated to be only 2 metres, but as can be seen from the chart furnished in the report in some cases the draw down was 6 metres. It was therefore necessary to reconcile the two. Further, the draw down of 6 metres would adversely affect the navigation between Sambor and Stung Treng.

It was also pointed out that during high water period, that is in the wet season, the effective head would be less than designed head of the turbines of the generating unit and the output would be less. These factors seem to need further examination before finalizing the installed capacity of the generating station.

5. Cost of thermal power : In determining the cost of thermal power higher price of fuel, six per cent interest and sixty per cent load factor have been assumed, thus the cost of thermal power is high. The attention

of the Sambor Team was drawn to the Moulton Report and the Team was requested to re-assess the cost of thermal power, taking into consideration the same rate of interest and load factor as in the case of Sambor Project and also take the cost of oil excluding import duty. Further assessment of thermal power should be made on the basis of installation of units of at least 200MW to make the comparison more appropriate.

6. The Sambor Team explained that a study was made to increase the firm power capacity of Sambor project by the addition of a thermal power station of an appropriate size in the system. One of the members of the Sambor Team promised to let the Secretariat have a copy of this study.

7. The pattern of power consumption assumed to determine the revenue to be derived from sale of power was that the firm energy will be consumed by domestic (general) load and by the Aluminum Industry. The secondary power by electro-chemical industries indicated in the report. The tariff assumed was 9 mills for domestic supply, 2.5 mills for aluminum refining and 2 mills/kwh for electro-chemical industries (secondary energy). It was brought to the notice of the Sambor Team that 9 mills/kwh for general supplies was high compared with thermal alternative and perhaps from national multipurpose hydro projects in Viet-Nam in particular. In order to enable the Republic of Viet-Nam to take Sambor power, the cost of power as delivered at Saigon will have to be less or at least equal to the cost of power from alternative sources. Therefore, the rate of 6 to 7 mills for domestic supply seems to be more appropriate. Further, the possibility of generation of power from nuclear energy at a cost of about 5 to 6 mills in nuclear power plants of 400MW capacity should also be recognized.

With regard to electro-chemical industries in view of the fact that most of the products of suggested industries are for export and the production would be only seasonal, it is doubtful if any entrepreneur would be attracted to establish the industry on a power cost of 2 mills/kwh. Therefore, it was suggested that if possible the Chemical Industries Association of Japan should be consulted and the assessment of revenue from secondary

energy should be based on the results of such consultation. It was also suggested that the secondary energy should be divided into blocks on the basis of availability such as 3 months period, 6 months period and 9 months period or other appropriate divisions and different tariffs should be assumed for each for determining the revenue to be derived from electro-chemical industries based on secondary power.

8. On page 7-8 it is mentioned that the caustic soda industry proposed to be established is for production of alumina. It was pointed out that investigations so far carried out have not revealed any exploitable deposits of bauxite. As such there is no possibility of conversion of bauxite into alumina in the Basin. The aluminum industry suggested to be established is to be based on imported alumina.

9. The Cambodian delegation suggested that the date of inauguration shown as 1978 should be omitted as it was doubtful that the first unit could be put in position earlier than 1980.

10. Mr. Khy Taing Idm also suggested that an annex should be added to the report, showing the capital cost and power requirements of aluminium industry and each of the electro-chemical industries mentioned in the load forecast. This statement should also indicate the probable return from such investment in each case.

Navigation Aspects (Chapter 9)

1. Initial Plan

(a) The proposed navigation facility included in this study should be mentioned in the report that it is based on the actual waterway transportation condition and on the assumption of the waterway transport in the near future, considered as a part of pre-development stage of navigation improvement prepared for the future development of waterway transportation if justified by the comprehensive transport and economic study in the Lower Mekong Basin.

(b) Construction of inclines, marine railway, hauling equipments etc. are proposed to be designed for receiving the maximum live load of 250 tons distributed on cradle of 30m length, therefore, specific live load will be 3.5t/m on track which is sufficient as well for the shorter ship but heavy such as tug, i.e. the safety depth of navigation channel in dry season being improved to be not less than 2.00m where the barge of 200 tons dw. could navigate safely, the slipway capacity should be designed for 250 tons (200 tons cargo + 5 tons hull weight) as maximum live load.

(c) As the marine railway is too long, the security measure in operation of the transfer of a loaded ship across the dam on slipway should be taken into consideration. Preventive measure for hull deformation during hauling the ship off the water should be studied. The wedge type cradle is hereby proposed, to be used instead of conventional rectangular type cradle in order to keep the loaded ship always in even keel position.

(d) Hydrofoil, boat as mentioned in the last paragraph of page 9-13 to be changed as speed crafts.

(e) The cost as estimated was based on 1965 rates. This should be estimated on 1967 rates (January), just same as the year for the power study.

(f) Cambodian delegates suggested the influence of additional Pa Mong releases on tail water at Sambor due to fluctuation should be studied to evaluate the effect on navigation.

2. Future plan

The navigation facility arrangement proposed in the report is based on the assumed quantity of freight transported by waterways up and down across the dam and will be provided by means of locks and canals system for the passage of ocean freighter of 3,000 tons dw. as a target of future plan.

The transportation by sea-going ship on the inland waterway far from the sea is commercially unrealistic. The daily normal expenditure of sea-going ship shows about three times higher than which of the barges and tug with the same carrying capacity, moreover, pilot fee, special rate of insurance, tug fee will be added on the sea-going ship expenditure while sailing in the inland waterways. Whereby the freight rate will be increased uncomparably. Sea-going ship is designed for sailing in open sea not in inland waterways, therefore ship's manoeuvrability on downstream with strong current, strong wind and part load will be less effective and will create the risk. The shipper from navigation sector or the transporter will choose the cheapest and safetlest way of transport; if for inland waterway transport, the transport by barge and tug seems to be the best.

The navigation possibility of the sea-going ship of 3,000 tons dw. in the river or canal of this stretch needs dredging to improve a channel with a minimum safety depth of 7.00m and breadth at least of 45m for a distance not less than 200kms and, also the locks and canal design will be of the appropriate dimensions, therefore, it will cost too much to the project.

As based on the need of waterway transport as mentioned in the report, the future target of navigation facility arrangement at dam is proposed to be for the passage of inland waterway vessels such as barges and tug with the maximum capacity as follows :

1. 500 tdw. barge with dimensions of 50m length x 8m breadth x 2.25m depth and maximum loaded draft 2.00m;

2. 900 HP pusher tug with dimensions of 27.5m length x 7.8m breadth and maximum draft 1.7m. Free running speed 18km/hr and speed on pushing train of 5 x 500 tdw. loaded barges is 12km/hr.

Therefore, the cost of construction of locks connecting canals and the cost of dredging of waterways will be reasonably low.

The above proposal for the future plan concerning navigation arrangement is subject to the justification of the comprehensive study of transportation and economic in the Lower Mekong Basin, which will be carried out in the near future.

Economic investigations and financial analysis (Chapter 10)

During discussions at Phnom Penh it was agreed that in the preparation of the final report the Japanese Sambor Team should take interest during construction at 6% into account in working out internal rate of interest. It was further agreed that the economic life may be taken 50 years as already assumed in the draft report. The Cambodian delegation insisted that the exchange rate to convert local expenditure should be taken at the official rate of 1 US dollar = 35 Riels and not at 1 US dollar = 60 Riels.

The total cost of the construction of project is estimated as 350.5 million US dollars (255.6 million in foreign currency and 94.9 million in local currency). Without taking the cost of interest during construction, the project does not give more than 5% internal rate of return. If interest during construction at 6%, equivalent to 76.3 million dollars is taken into account, benefit-cost ratio would be as shown below:-

(a) based on 6% interest rate : 0.80

(b) based on 4% interest rate : 1.12

In order to obtain a satisfactory benefit-cost ratio (i.e. from 1.3 to 1.5), the required funds have to be obtained at a rate of interest of 3% or so. It will be very difficult to raise funds for the project from international investment sources at such low rate of interest. On the other hand, the additional power that it will be possible to generate at Sambor dam from the Nam Ngum and Pa Mong reservoir system releases, improves the economy of the project very considerably.

Effects of Nam Ngum and Pa Mong projects on the Sambor project (Chapter 11)

Nam Ngum dam is already under construction, the estimated increase of inflow at the Sambor reservoir in the dry season due to Nam Ngum is calculated as 7 per cent.

As regards Pa Mong dam, the draft project inChapter 11 has calculated the effect with 3 different assumptions for total effective storage capacity equivalent to 21, 900 million cubic metres; 39, 832 million cubic meters, and 62, 500 million cubic metres (page 1-99 of Volume II).

The USBR Team has further revised the storage capacity of Pa Mong reservoir based on the latest topographic maps and has given out figure of 75, 000 million cubic metres. With the addition of Nam Mong and Nam Lik reservoirs, the total capacity of the Pa Mong system will be increased to 103, 000 million cubic metres.

Both Cambodia and the Mekong Secretariat considered it absolutely necessary that the full effect of the enlarged storage of the effective releases from the Pa Mong reservoir system for generating additional power at Sambor should be recalculated. In order to help the Japanese Sambor Team the Mekong Secretariat undertook to carry out power output studies at Sambor from the revised Pa Mong releases with the help of the Mekong Electronic Computer, using the revised hydrologic data and the regulated flow from the Pa Mong reservoir system.

It was also considered necessary that market for the additional power that can be generated from the Sambor, with the help of the Nam Ngum and Pa Mong, should be further explored.

Preliminary examination of the figures indicated that taking Nam Ngum and Pa Mong releases into consideration, the Sambor project can be shown to be definitely feasible not only from the technical point of view, but from economic point of view as well.

Additional time required

The Japanese Sambor Team felt that in order to recalculate the effect of enlarged releases from Pa Mong on Sambor power and reassessment of economic evaluation of the project on the lines of the discussions at Bangkok and Phnommpenh about 3 months more than comtemplated in the plan of operation will be needed in finalizing the report. Dr. Aki assured the meeting at Phnom Penh that the Japanese Sambor Team would be able to submit the English version of the final report by March 1969. The French version will be submitted a few months later. This position was accepted by Cambodia.

ACKNOWLEDGMENT

The Mekong Secretariat wishes to record its sincere appreciation of the cordial atmosphere in which the discussions were held between the participants, both at Bangkok and Phnom Penh. This was, to a great extent, achieved due to the personal qualities of leadership of Dr. Koichi Aki, leader of the Japanese Sambor Team, and Mr. Khy Taing Lim of the Cambodian delegation, who gave his valuable tise in presiding over all the meetings at Phnom Penh.

The members of the Japanese Sambor Team and the Mekong Secretariat wish to convey the gratitude to the Royal Government of Cambodia for providing facilities for holding the meetings at Phnom Penh. They particularly wish to thank Mr. Khy Taing Lim for his high qualities which enable the meetings at Phnom Penh to lead to recommendations which will be found to be very useful during the preparation of the Sambor Project final report.

All the participants also express special thanks to Mr. Guy Dalebroux, who worked incessantly in carrying out the difficult task of interpretation at Phnom Penh.

ANNEX""A"

ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST

Committee for co-ordination of Investigations
of the Lower Mekong Basin

(Cambodia, Laos, Thailand and Republic of Viet-Nam) 1 July 1968

Informal discussions on Sambor Project Draft Report

Monday 8 - Friday 12, July 1968

Bangkok, Thailand

LIST OF PARTICIPANTS

Republic of Viet-Nam

Japanese Sambor Team

Dr. Koichi Aki	Leader (General - incl. Navigation)
Mr. Takeshi Tokuno	Member, Civil Engneering Aspect (inc. Power Market)
Mr. Nobumichi Shuto	Member, Economic Aspect (inc. Power Market)
Mr. Kensaku Takeda	Member, Irrigation & Agriculture Aspects
Mr. Mitsuharu Sato	Member, Co-ordinator

USBR Pa Mong Team

Mr. L.W. Mabbott	Project Engineer, USBR Pa Mong Team
Mr. R.T. Sipinen	" " "
Mr. N.H. Tippets	" " "
Mr. L.R. Blass	
Mr. Thaipuok Thammongkol	

ECAFE

Mr. P.T. Tan	Chief, Division of Water Resources Development
Mr. R. Price	
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Mekong Secretariat

Dr. C. Hart Schaaf	Executive Agent
Mr. Kanwar Sain	Director of Engineering Division
Mr. M. Hayath	Power & Industry Adviser
Mr. Roem Purnariksha	Agricultural Adviser
Mr. J.P. Sevilla	Construction Engineer
Mr. Boonchob Kanch analak	Hydrology Consultant
Mr. H. Hori	Planning Engineer
Mr. Samarom Bunnag	Shipbuilding Engineer
Mr. B. J. Wolhwend	Navigation Legal Officer
Mr, Chamlong Tohtong	Economic Affaire Officer
Miss Nguyen T. H.	Bilingual Secretary
Mr. Phornchai Athikhomkulchai	Secretary

ANNEX "B"

ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST

Committee for co-ordination of Investigations
of the Lower Mekong Basin
(Cambodia, Laos, Thailand and Republic of Viet-Nam)

16 July 1968

Informal discussions on Sambor Project Draft Report

Monday 15 - Thursday 18, July 1968

Phnom Penh, Cambodia

LIST OF PARTICIPANTS

Cambodia

Mr. Khy Taing Lim	Directeur de l'Hydraulique et de l'Energie
Mr. Peng Ponn	Directeur adjoint " "
Mr. Songthara Om Kar	Direction de L'Hydraulique et de l'Energie(D.H.E)
Mr. Yoan An	Division Electrification (D.H.E)
Mr. Seng Auv	Division Technico-Economique (D.H.E)
Mr. Khloeung-Isar	" "
Mr. Mey Phath	Chef du Service de l'Hydraulique et des Voies Navigables
Mr. Leang Chhun Veng Muy	Service de l'Hydraulique et des Voies Navigables
Mr. Khehau Rin	Representant de la Direction de l'Agriculture
Mr. Samreth Lamhiem	Division du Genie rural, Dept. de l'Agriculture
Mr. Mok Lim Hour	Division de Construction (D.H.E)
Mr. Pa Pheng	Directeur de la Centrale Hydroelectrique de Kirirom
Mr. Ya-Meng-Haeng	Direction des Eaux, Forets et Chasse
Mr. Sok Mathoeung	Direction des Peches
Mr. Sva Kret	" "

Japanese Sambor Team

Dr. Koichi Aki	Leader (General - inc. Navigation)
Mr. Tkeshi Tokuno	Member, Civil Engineering Aspect (inc. Power Market)

Mr. Nobumichi Shuto	Member, Economic Aspect (inc. Power Market)
Mr. Kensaku Takeda	Member, Irrigation & Agriculture Aspects
Mr. Mitsuharu Sato	Member, Co-ordinator
Mr. Masamoto Yasuo	OTCA Representative at Phnom Penh

Mekong Secretariat

Mr. Kanwar Sain	Director of Engineering Division
Mr. P.T. Tan	Chief of Division of Water Resources Dev., ECAFE
Mr. M. Hayath	Power & Industry Adviser
Mr. H. Hori	Planning Engineer
Miss Nguyen T. H.	Bilingual Secretary
Mr. G. Dalebroux	Chief Interpreter / Translater

3. 1968年7月に行なわれたDiscussionのメモに対する日本側のノート

From Dr. K. Aki to Mr. Kanwar Sain, Oct. 1968

1. Statistics (Capter 2)

In relation to statistics of Chapter 2, the figures pointed out shall be updated with reference to the 1967 U.N. Statistical Year Book, the U. N. Monthly Bulletin and the Mekong Statistical Bulletin of recent issue, as far as possible. As we have no expendience here to refer to the Mekong Statistical Bulletin, we request the Secretariat to send us the latest issue of the bulletin for the revision of energy figures appearing in page 2-16 of the report.

All the statistics on population, industries, foreign trade and transportation in volume IV (Navigation) are dated before 1962. To update these statistics, we request the Secretariat to provide, as soon as possible with the latest statistics titled "Annuaire Statistique du Combodge" issued by the Government of Cambodia.

2. Mineral Resources (Page 2-12)

Pertaining to the mineral resources map on page 2-12, necessary corrections shall be effected based on a new map which we request the secretariat to send us at an earliest possible date. The new map may be reproduced or copied on a smaller scale.

3. Hydrology and Water Resources (Chapter 2 - Para. 2.12, Page2-5, 2-6)

(1) The precipitation around the Grand Lac shall be corrected to 1,000 - 1,500mm.

(2) The descriptions shall be improved cautiously.

(3) The water-level shown in Fig. 2-6 was not based on M.S.L. but taken from gauge readings. A remark to this effect shall be added in the Figure 2-6.

(4)-(8) The descriptions shall be improved cautiously.

(9) Records of the two sites can be more clearly presented in one graph by curve than by bar. Presentation by bar-scale is considered unnecessary.

(10) Our study is based on run-off data of Kratie which was provided by the Secretariat in April 1967. The data seem, as indicated in the minutes, correlated with those of Stung Treng. As for missing data, November and December 1952, January through April 1953, and the year of 1954, we computed them by correlation with Pakse. (See Chapter D-4, Volume II)

(11) The run-off data of Kratie covering 33 years from 1933 to 1965 were, as stated above, proficed by the Secretariat in April 1967.

Improvement of the study as requested is impossible at present, but might be made provided that such expanded data or modifications as mentioned in the Minutes are made available.

(11)-a Modified maximum flood of 64,000 cms as against original 73,600 cms will bring no appreciable effect on design flood since modified figure remains within safety range.

(11)-b As for minimum dry season flow record of 1933, replacement of 1,160 cms by 1,480cms will not have appreciable influence on the basic frame of the project except for incidental minor modifications in available drawdown, power output and annual energy production. The available drawdown, power output and annual energy production shall be 5m, 875,000 kw and 6,393,600,000 kwh respectively instead of present figures of 6m, 874,600 kw and 6,387,100,000 kwh. Although the data for the years from 1924 to 1933 have not been made available to us, it seems that no material change will be caused by computation of power production of expanded 44 years instead of 33 years. (See also (25) (26) and (3)-(4) in 7. Power Aspects)

Some explanation shall be added in the Report concerning the extreme drawdown 6m. However, it might be modified depending upon the results of further studies on the subject.

(12) It is rather difficult to conduct related necessary studies for reasons given in item (11) above.

(13) Water level was observed at the tailrace site periodically at 9 a.m. on the 1st and 15th day of each month. (See D-5, Volume II) Since the observation was conducted for the specific purpose of obtaining data to develop a rating curve of the tailrace, satisfactory data are obtainable by observation twice a month.

(14) On the basis of actually observed records, the relationship between run-off and water level at the dam site was first sought against fluctuation in water level from 6m to 21m. The water level at design flood discharge was estimated by exploration of a regression curve which was developed based on the said relationship. This method will suffice in view of the fact that flood will over-bank before it reaches EL. 21m.

(15) The description shall be improved cautiously.

(16) Generally, it is the fact that the nearer the groundwater approaches to the delta, the nearer its elevation approaches to the ground surface. But there was an exception within the limited area of complicated topography of 34,000 ha. The observed water level, which must be considered an exception, shall be omitted in the Report.

(17)-(18) In view of the proposed upstream reservoirs, 101,000cms has been employed as the design flood discharge which is obtained in the 1,000-year return period by the Gumbel Method. This fact was explained at the joint Pa Mong and Sambor Meeting. In case flood records are corrected as indicated in (11)-a of the minutes, 10,000-year flood will be as follows

on the basis of flood records covering the years from 1933 to 1965:

83,000cms by log-normal distribution

105,000cms by Gumbel Method

81,000cms by Hazen-Foster (Type 3)

Computation by enveloped curve flood technique will give a peak flood of 88,000cms based on the drainage area of 646,000km^2 and assumed coefficient of 110.

(19)-(20) The results of the flood control studies are given in Chapters D-6 and F 2 of Volume II, as well as in Chapter IV of the Appendix. These should naturally be reexamined in case the design flood discharge be changed or the Pa Mong and Stung Treng Projects are finalized.

(21)-(24) As for suspended sediment concentration, studies may be conducted if the Secretariat makes available records of actual observation by the riparian countries.

(25)-(26) No correction shall be made in navigation aspect so long as the values of the maximum and minimum flows cited in (11)-a and b, respectively, should remain the same.

Chapter F-3 of Volume II gives a description of the reservoir operation under dry season minimum flow.

(27) Detailed explanation of reservoir operation shall be given in the Report.

(28) The description shall be improved cautiously.

(29) An emergency-type spillway may be adaptable. However, detailed studies should be conducted from technical, economic as well as social points of view to decide its best location. Such studies should preferably be made in the stage of the definite studies of the Project.

4. Irrigation Aspects

(1) The question is that the cost of 51,000 Riels (862 US$) per ha. looks rather high:

Construction costs of the works are estimated as follows:

Land reclamation works (28,983 ha)	$8,500 \times 10^3$ US$
Irrigation canal works (557.4km)	$7,800 \times 10^3$ US$
Drainage canal works (30.5km)	520×10^3 US$
Pumping stations (27 places)	$4,160 \times 10^3$ US$
Reservoir works (13 places)	$2,432 \times 10^3$ US$
Colmatage works (8 places)	962×10^3 US$
Sub total	$24,374 \times 10^3$ US$
Reserve funds, Engineering fees & Demonstration farm	$4,934 \times 10^3$ US$
Sub total	$4,934 \times 10^3$ US$
Grand Total 34,000 ha	$29,308 \times 10^3$ US$
	(862 US$/ha)

As mentioned above, the Project involves many items of construction works which are necessary to develop the land entirely. Land reclamation of the paddy and upland fields covers land levelling, installation of pumping stations and construction of irrigation canals including terminal facilities up to each farm lot, and accordingly, these works possess a considerable big portion of the total cost. Most of the irrigation systems hitherto constructed in the existing cultivated land in Cambodia, are consisted of the main facilities only, in comparatively cheaper cost and with less effectiveness.

The project cost of the Sambor agriculture development may, therefore, be reasonable from the above point of view as well as in comparison of both benefits.

(2) Desirability to increase the irrigable area by gravity from Sambor Dam:

Benefited area of 34,000 ha has been selected by excluding the area whose adverse topography and non-fertility of soil incure an increase in the cost.

However, by the anticipated increase of water discharge of Sambor Dam in the dry season, influenced by Pa Mong dam operation, it might be possible to irrigate the delta area in the lower reaches. The Report gives a description of the desired development of the Mekong Delta that will hopefully be materialized by the expected discharge increase. However, studies in the past have been conducted on a preliminary level for the possible agricultural development of 587,000 ha.

(3) Efficiency of irrigation of paddy looks to be too high

The efficiency of paddy irrigation in the report is estimated to be 75% in the Report. The figure will be considered reasonable by the following reason.

That is, the project involves main and lateral canals, and terminal facilities. These canals will make it easy to distribute water and minimize loss. It is also desirable to establish the way of maintenance and control measures for these advanced facilities, whereby the utilization of water may be effectively practiced by farmers.

5. Fisheries Aspects (Page 5-16)

Concerning the fisheries aspects, further explanations will be given in the Report, after careful examination of the problems referred to in the Summary Minutes.

6. Legal Aspects (Page 5-4)

With regard to legal aspects, amplified descriptions will be given

with reference to the comprehensive note prepared by Messrs. D. Caponera and B. J. Wohlwend. Since we have only the original French texts, "Le Droits et l'Administration des Eaux par D. A. Caponera, 1967" (au Royaume du Cambodge, au Royaume du Laos, et dans la Republique du Viet-Nam), we request the Secretariat to send us a copy of the note and copies of English version of "Le Droits et l'Administration des Eaus", as early as possible.

7. Power Aspects

(1) As for power demand forecast, the opinion of the Secretariat differs from that of the Cambodian Government.

No further study shall be made pending availability of evidences supporting either of the two opinions.

(2) In view of the development of national projects, it is assumed that the Sambor will supply 60% of the increased demand expected in the project area. It is believed that the development of national projects will take place after completion of the Sambor. In this connection, 60% is rather conservative and no modification is necessary at the present time. As regards the case of 90%, however, re-calculation might be made in our study.

(3) Description of firm power capacity shall be modified according to the international standard. However, power consumption program shall remain unchanged.

(4) As for the size of generating units, a detailed explanatery note shall be prepared. Results of re-examination of drawdown shall be included in the report. Decrease of power output in the wet season has been taken into account in determining particulars of the turbines and generators. (See Chapters F-4 and F-5, Volume II)

(5) A detailed explanatory note shall be prepared separately on the

cost of alternative thermal.

(6) A copy of the study in question shall be forwarded as a personal view by the Japanese member referred to the Minutes.

(7) A detailed explanatory note shall be prepared separately on the unit charge of electricity and consumption of secondary energy.

(8) In the report, import of bauxite is assumed. Whether or not the proposed alminimum industry should be based on imported alumina is a matter to be dealt with in the detailed study.

(9) The study has been developed on the assumption that will be in operation in the project in 1978. The final report will not state that the project would be in operation in 1978, but that it is technically possible to complete the project in 1978. However, the date of operation of the project would be re-examined in the preparation of report.

(10) Description of power-oriented industries including alminium industry are given in Chapter C-2 of Volume II. A financial program for the industry shall be included in the report.

8. Navigation Aspects (Chapter 9)

(1) Initial Plan

(a) Sections C, E and F of Volume IV are devoted for the determination of the type and scale of navigation facilities and also for the estimation of the type and quantity of ships and cargoes to be handled by the facilities.

(b) The size of barges, which are to be passed over the dam, is determined to be of 150 ton class for the purpose of designing the inclined plane system, in view of their sizes presently in service and the kind and

volume of future cargoes.

Load factors to be taken into consideration in designing the shipway are:

Weight of cargoes	150 tons	
Dead weight of hull	50 tons	Total of 235 tons
Dead weight of cradle	35 tons	

The total load is then multiplied by 1.2 times, and the obtained value of 282 tons is adopted as the design load to allow for shocks and other factors. The capacity of the winch and ancillary facilities are determined on the basis of this design load.

(c) When a ship, placed on the cradle, is hauled off water, the ship's hull will be subjected to deformation due to the reverse pressure. To prevent this, it has already been thought out to support the ship's loads by hammering square and wedge type wooden blocks in between the cradle and ship's hull.

(d) The term of "hydrofoil" has frequently been used in overseas technological journals. The words "speed craft" may be used in lieu of "hydrofoil". The Sambor team is, however, of the opinion that the latter is correct.

(e) The 1965 rates would be replaced by 1967's.

(f) The construction of the Pa Mong and Nam Ngum dam in addition to the Sambor will create conditions considerably favorable for navigation as it is expected to raise the water-level by about 1.0 - 2.4 meters in dry season at Kratie.

(2) Future Plan

No modification of the future plan will be made in the Report as our study has been based on the Secretariat's previous view in this respect.

However, further study of the Secrtariat on this subject will be much appreciated.

9. Economic Investigations and Financial Analysis (Chapter 10)

(1) In the economic analysis of power generation sector, percentages equal to internal rate of return have been taken into account as interest during construction, i.e., 4.4% for Type I, 5.3% for Types II and III.

(2) Conversion rate shall be specified in the report as follow:
1 U.S. dollar = 35 Riels

(3) Pertaining to economic investigations and financial analysis, the team wishes to do the best in co-operation with the secretariat in order to accomplish the study, noting the suggestions made at the Summary Minutes of Informal Discussions.

(4) With respect to the effect of Pa Mong and Nam Ngum upon Sambor, the following data have been made available to the Team through the courtesy of Mr. Tippets, Water Resources Development Division of ECAFE and Mr. Kanwar Sain.

These data are now under review.

Mr. Tippets: Studies No. MC 19 & No. MC-20

ECAFE: 1) Calculated data, Sambor with Nam Ngum and Pa Mong 250m, at 15 years of its completion

2) Calculated data, Sambor with Nam Ngum and Pa Mong 250m, at 50 years of its completion

Mr. Kanwar Sain: Sambor Project - Reservoir Operation with Flow Regulation of Nam Ngum and Pa Mong Reservoir, (MP/A.1003 TEC322-(3-2), Sep. 18, '68)

(5) Assumptions regarding the market for additional power that can be generated from the Sambor constitute an important factor of the project. Accordingly, the Team wishes to exchange opinions with the Secretariat about such assumptions.

4. アルミニューム工業に関するHayath氏のノート

MP/A. 721
TEC 322 (6-8)

4 July 1968

Dear Dr. Aki,

Global Power Market Survey Aluminum Industry

I wish to enclose herewith a copy of the report entitled "Trends in the World Aluminum Industry"* prepared by the Resources for the Future as well as a copy of the note prepared in this office on the above subject for favour of your information.

With personal regards,

Yours sincerely,

M. Hayath
Power & Industry Development Advis

* "TREND IN THE WORLD ALUMINUM INDUSTRY", by Sterling Brubaker, 1967, Published for Resources for the Future, Inc., by THE JOHNS HOPKINS PRESS, Baltimore

(編者 註)

5 June 1968

GLOBAL POWER MARKET SURVEY

Summary of the Report entitled
"Trends in the World Aluminum Industry"

Study conducted by Resources for the Future partly at the request of the Committee for Coordination of Investigations of the lower Mekong Basin

The report is very comprehensive and is loaded with extremely useful information for the aluminum industry and for the countries, particulary developing countries, contemplating establishment of aluminum smelters for export. It analyses in great detail various aspects of aluminum industry which influence the location of smelters for producting aluminum for indigenous use as well as for export purposes.

According to the data collected by the Resources for the Future, world consumption of primary aluminum in 1966 and anticipated demand by 1980 (excluding the communist block) as well as the production capacity and announced plans for production of aluminum is as follows :-

Region	Existing capacity	Announced capacity	Existing and announced capacity	Expected demand by 1980	Additional capacity required
		(thousand metric tons)			
Europe	1426	658	2084	4035	1951
Latin America	88	43	131	525	394
United States and Canada	3546	479	4025	6370	2345
Asia	460	155	615	1485	870
(Japan)	(340)	(110)	(450)	(985)	(535)
Africa	53	144	197	195	-2
Oceania	96	48	144	290	146
Total	5669	1527	7196	12900	5704

from the above it will be seen that even if the plans are implemented fully, there will be need for establishing additional production capacity of the order of (consumption being on the basis of 85% of the production capacity) 8 million metric tons for meeting assessed anticipated demand by 1980. This means that the capacity of the industry must be more than double by the target date of 1980. Apart from Japan, the heaviest consumption of aluminum is in Western industrially advanced countries.

Aluminum industry is capital intensive. It is at present concentrated in the hands of about 10 large undertakings, six of which are in the U. S. A. These companies own smelters mostly in the centres of consumption, own mining concession for bauxite all over the world, either own or have controlling interest in conversion of bauxite into alumina at the ore mines and have also large interest in the aluminum processing industries all over the world. Therefore, the study concludes that it is unlikely that developing countries would be able to establish smelters in their countries without technical and financial collaboration from one of these giant concerns.

The general pattern of the existing industry is as follows :

Bauxite is mined and converted into alumina as far as possible at the site of the bauxite mine. Alumina is transported to smelters located in industrially advanced countries and in some cases located in countries wherever favourable atmosphere has been found for location of smelters. Aluminum produced in the smelters is largely utilized for various purposes in the industrially advanced countries with the exception of England where ingot aluminum is imported, and exported to aluminum deficit, industrially advanced countries and to developing countries. The metal is processed into saleable product in various countries where the demand for the product exists. In short, the industry from mining of bauxite to processing to saleable products is either owned or controlled by these large undertakings. Some developing countries, to make themselves self-sufficient, have established aluminum smelters to meet the domestic demand to some extent but

so far, no country has attempted to establish aluminum industry for production of primary metal for export purposes without the assistance and coordination of these giant undertakings and as far as can be seen, there does not seem to be any likelihood of any developing country establishing the industry by itself for export purposes in the near future. As far as Japan is concerned, the picture is slightly different. The report summarizes the position in Japan as follows :-

"Japan presents a special case. Heretofore the Japanese have maintained a policy of self-sufficiency in ingot well protected by trade barriers. The possibilities of economical expansion for a booming Japanese market are not bright with conventional energy sources. On economic grounds it would seem plausible to expect the Japanese to seek outside sources of supply. Conceivably they might become straight importers of Canadian or Australian metal. However, the more familiar pattern is for the Japanese to prefer control or joint ownership of their sources of supply and to prefer domestic production even if it involves some cost penalty. Recent adherence to GATT and OECD complicates the problem for Japan and may compel it to adopt a more open attitude. Unless it can reduce power costs, this development might force Japan to consider a wide variety of possibilities in the Pacific basin ranging from Australia and Southeast Asia to Alaska, and would make some affiliations abroad in the production of metal for the Japanese market seem a somewhat more likely possibility. However, in Japan, as in Europe, the development of cheap atomic power should revitalize prospects for domestic expansion, and the Japanese would seem most likely to seek to supply their own needs under such circumstances."

The most important items which influence the location of aluminum smelters are : -

a. Power, b. transportation and c. labour.

Existence of large deposit of bauxite in developing countries of the world seem to lead to a belief that it will be more economical to locate alumi-

num production plants at the site of the bauxite mine. The following analysis will reveal that the above is not quite true for various reasons : -

a. Power

Even though power is a large ingredient for the production of aluminum, importance of cheap hydro power is loosing its weight in the production of aluminum. About 15 years ago, the cost of power in conventional thermal power plants was of the order of 8 mills/kWh and the cost of nuclear power had not yet been sufficiently accurately determined. Hydro power at favourable sites where cost was of the order of 2 mills/kWh attracted the attention of aluminum industry and prompted investigations for location of the industry at the site of cheap hydro power. The difference between cost of thermal power in conventional power plant and the hydro power was large enough to consider its possibility of covering investment risks in the developing countries and extra transportation cost involved in shipping aluminum ingot from smelters located in developing countries. Recent technological developments have brought about considerable change from this position. In the U.S.A., the thermal power in conventional thermal power plants is being generated at about 4 to 5 mills/kWh by installation of large size generating units and adopting higher temperatures and pressure securing considerably higher efficiency. Production of electric power by nuclear energy has made many forward strides in recent years. With the result that power generation in developed countries by nuclear energy has reached a cost level equal to that of conventional thermal power plants and claim is putforth that in large capacity nuclear power stations cost of generation is less than that in the conventional thermal power plants.

Thus the difference between the cost of thermal power (in conventional power plants and nuclear power plants) and most advantageously placed hydro power is diminishing gradually. The present difference of about 2 to 3 mills/kWh, which may get reduced further with the technological developments, is considered inadequate to cover investment risks involved

in the investment of large capital in less developed countries as well as to cover extra transport cost involved in transporting aluminum ingot to processing industries located in industrially advanced countries. Therefore, the so-called cheap hydro power though a major element in the cost of production of aluminum is loosing its weight.

This conclusion seems to gain weight from the fact that in the world, particularly in Africa there are very favourable hydro electric sites located fairly near large deposits of bauxite and also very near the deep sea ports. For example, Inga in Congo which has a power potential of 25 to 30 million KW and the cost of generation at the time it was investigated was assessed at 1 to 1.6 mills/kWh. This site happens to be near a large source of bauxite as well as near a deep sea port. Inspite of these advantages, aluminum companies have not so far moved to establish smelters in the area due to very high investment risks involved. Similarly, there are some more sites in Congo and in Guinea where power may be generated at $1\frac{1}{2}$ to 3 mills/kWh. Still, there is no indication of any of these companies attempting to establish aluminum smelters in the area.

b. Transport

The study reveals that presence of large bauxite deposits in the developing countries exercises comparatively little influence on the location of the smelters for the following reasons :-

For production of one ton of aluminum, 4 to 6 tons of bauxite is required which can be converted into 2 tons of alumina. Bauxite is inexpensive to mine and transport. Similarly, alumina is also inexpensive to transport. The cost of transport of bauxite and alumina is at present of the order of $1\frac{1}{2}$ to 2 mills/ton mile. Construction of large size carriers and highly mechnized methods of loading and unloading is reducing the cost of transport of bauxite and alumina considerably but the cost of transport of aluminum ingot is 2 to 3 times the cost of transport of bauxite/alumina. Even though large deposits of bauxite are found in developing countries,

in view of major consuming centres of aluminum being industrially advanced countries there is not much advantage in converting bauxite into aluminum metal at the bauxite mine. Therfore, the pattern of development has been that bauxits is converted into alumina at the bauxite mine and transported to smelters in the industrially advanced countries. As to capital investment for establishment of plant for conversion of bauxite into alumina is comparatively small, the aluminum producing companies have established these plants at banxite mines, thus reducing the transport cost to nearly half. It is also stated that political pressure may have lead to this practice rather than economical considerations as transport cost is small compared with the cost of metal.

c. Labour

It is generally believed that the cost of labour in the developing countries is very low. This is considered as a point in favour of establishing smelters in the developing countries. The aluminum industry is not labour intensive. It is at present of the order of 14 man/hours per ton of alumina. In some industrially advanced countries like America, it is even less. Increasing automation in the industry is reducing the number of man hours every year. At present, the labour cost per ton of metal is assessed as follows :-

U.S.A	$60 per ton
Japan	$40 per ton
Less developed countries	$30 per ton

The difference is narrowing gradually due to increased automation and rising wages in the developing countries. Necessity of providing amenities to labour such as housing etc. in developing countries is reducing the difference between the wages in industrially advanced countries and developing countries. However, the difference is not very large to encourage undertaking investment risks involved.

Capital Cost

The smelters in the 100 to 200 thousand metric tons per year range laid down in the industrially advanced country is estimated to cost about $700 per ton of capacity. The equivalent size of plant in the developing country will have to bear a higher initial cost. This is due to the fact that transport of equipment is involved and for lack of technical personnel for installation and initial operation, foreign experts, at considerably higher cost, will have to be obtained. The increase can be of the order of 10 to 25% depending upon circumstances. Further, foreign investors would expect a higher return in the investment made in developing countries as compared to return anticipated in developed countries. Thus, two factors will add considerably to the cost of production of aluminum in the developing countries.

Thus, it will be seen that the many advantages which existed about 15 years ago for consideration of establishment of aluminum smelters in developing countries are diminishing year by year. Therefore, investors that is large aluminum producing companies do not seem to have any incentive or inclination to think of establishing aluminum smelters in developing countries for export of aluminum ingots to industrially advanced countries.

As far as the lower Mekong Basin is concerned, applying the results of the above study, the following picture emerges : -

If an industry for the production of aluminum (smelters) is to be established, it will have to be mostly export oriented, as the consumption of aluminum in the four riparian countries is comparatively small and no industry can be established for the production of aluminum economically for meeting the requirements of the four countries only.

With regard to the power as of date, the picture does not seem to be attractive as far as the large aluminum producing companies are concerned.

According to assessments made so far the cost of power from mainstream project at the high tension terminal of the generating stations is of the order of 3 to 4 mills/kWh. As the power production sites are located about 200 miles or more from the nearest deep sea port at least 1 mill/kWh will have to be added to the cost of generation to determine the cost of power as delivered to smelters established nearest to the deep sea port which is essential for reducing the transport cost of raw materials, which in this case are to be imported and finished products.

In view of this high cost of power and the investment risk in this area being high, there does not seem to be any attraction for the large aluminum producing companies to establish smelters in the Mekong Basin based on imported alumina with the objective of exporting aluminum ingots to industrially advanced countries. However, it may be mentioned that inspite of the diminishing advantages detailed in the RFF Study, some smelters have been established in developing countries such as in Ghana and Congo, due to long term contracts having been entered into for power supply at attractive terms and favourable atmosphere having been created for foreign investment.

It is to be recognized that even though the cost of power for the Mekong Mainstream projects as at present assessed is of the order of 4 to 5 mills as delivered at a deep sea port, it would be possible to reduce the cost of power for electro-chemical and electro-metallurgical industries such as aluminum by appropriately increasing the cost of power supply for general purposes which in itself would still be lower than the cost of generation by alternative means.

As already stated, Japan presents a special problem (see para). The opinion expressed in the report is that even though Japan has maintained a policy of self-sufficiency in ingot well protected by trade barriers, the possibilities of economical expansion for a booming Japanese market are not bright with conventional energy sources. However, the

door for obtaining cheap atomic power is open to Japan also. There are possibilities of Japan either becoming a straight importer of Canadian or Australian metal or making an effort to establish smelters with joint ownership and controlling interest in other developing countries. For this purpose, obviously it is necessary to provide cheap power and other attractive facilities so that the advantages to accrue will adequately compensate for the investment risks involved and for the extra cost in transport of ingot from place of production to Japan. Adherence of Japan to GATT and OECD may require Japan to look favourably such a propositions. Therefore, as far as can be seen at present, the only opening for the Mekong Committee is to interest the Japanese aluminum industry to consider the possibility of establishing aluminum smelters in the Basin at an appropriate place in the Basin. It is to be understood that if any of the large aluminum producing companies is interested in theproposition, it would be most welcomed.

As can be seen from Table 1, Japan is required to establish additional production capacity of 435,000 tons by 1980 over and above existing capacity and announced addition. Consumption of aluminum will grow further in the decade 1980-90. Therefore, additional capacity would be required by Japan. Establishment smelters of about 200 thousand tons per year capacity in the Mekong Basin would be advantageous to Japan as well as the Mekong Committee in the implementation of its Mainstream projects.

5. 洪水量の最新資料

Estimates of Maximum Probable Flood of Lower Mekong River

17, February 1969
(ECAFE : ICHIURA)

Site	Drainage area sq. km	Recorded max. flood cms	Max. Probable flood cms	(4)/(3)	(4)/(2) cms/km^2
(1)	(2)	(3)	(4)		
Luang Prabang	268,000	25,200(1966) (17,600)	40,000[a/]	1.6 (2.3)	0.150
Pa Mong	300,000	24,900(1966)	50,000[b/]	2.0	0.166
Upper Thakhek	357,000	-	78,000	-	0.22
Thakhek	373,000	32,900(1948)	82,000	2.5	0.22
Mukdaham	391,000	36,200(1963)	90,000	2.5	0.23
Khemarat	417,000	-	96,000	-	0.23
Pakse No.3	419,000	-	96,400	-	0.23
Pakse	539,000	44,700(1939)	115,000[a/]	2.6	0.21
Khone Fall	553,000	-	138,000	-	0.25
Stung Treng	635,000	62,800(1939)	157,000	2.5	0.25
Kratie	646,000	66,700(1939)	160,000[a/]	2.4	0.248

a/ Preliminary estimates by the Corps of Engineers.

b/ From the Interim Report of Pa Mong project, January 1969.

（収録－佐藤光春）