

PRIME MINISTER

GUANGDONG NUCLEAR POWER STATION

You asked for Walter Marshall's views.

He has made his views clear to the Departments of Industry and Energy - Flag A is a long paper, which he describes as a draft, produced when he heard that decisions were imminent on approaching the French. His central point is that the fuel supply contract is the real prize. He compares it to the sale of razor blades in the razor manufacturing industry. He and his colleagues in the industry have seen no sign that Industry/Energy have given serious attention to securing the fuel contract. He believes that if the French are now approached, even tentatively, with the thought of splitting the nuclear and conventional contracts, their position on fuel supply would be overwhelming.

The Department of Energy have gone a long way towards meeting Marshall's point by redefining an approach to the French as exploratory, and on the basis that the talks would in no way commit the UK to participate in an Anglo/French package. But the Industry/Energy argument is based essentially on the need to pre-empt a unilateral French bid for the package, and we have no evidence that they have accepted Marshall's view that the fuel contract ought to be our over-riding interest. Of course, Marshall sees it purely in terms of our nuclear industry interest, whilst Industry have to look at the prospects for other areas of British industry.

You have already seen the Lord Privy Seal's letter (Flag B) proposing "early and substantive discussions with the French". The Chancellor (Flag C) has not dissented from the idea of an approach to the French - he is more concerned about the Chinese angle. Mr Howell (Flag D), as I have noted above, pressed for the discussions with the French to be exploratory and with options clearly left open. Industry (Flag E) originally proposed an approach to the French.

/There is

① More open exploratory discussions with French keeping other options open. ② Surely Hong Kong does not have to buy electricity for this power station? If it gets nothing? The contract - cannot not build a smaller station in H.K.?

There is never an ideal way to second guess the French. Marshall must be right in his assumption that we will put the French in a very strong position on the fuel contract if we now approach them with any suggestion of dividing the nuclear and conventional contracts between France and Britain respectively. I doubt whether any contacts with the French can guarantee that they will not go it alone. As things stand, I believe that your colleagues are about to agree to some approach to the French, although they are not yet decided about the basis on which to open the discussion.

If you feel that some collective discussion is necessary before any step is taken, this might be within the EX framework, although it will need to happen very quickly. How would you like to proceed?

5 January, 1981

United Kingdom Atomic Energy Authority

11 Charles II Street
London SW1Y 4QP

From the Deputy Chairman
Dr W Marshall, CBE, FRS

Telephone: 01-930 5454

STRICTLY PERSONAL

5 January 1981

Mr M Patterson
10 Downing Street
London

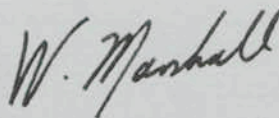
Dear Mr Patterson

On the telephone today you told me that the Prime Minister wanted to have my personal views on the Guangdong project and the proposal to have early discussions with the French. I told you that I had set out my views in a letter and paper to Mr Manzie of the Department of Industry just before Christmas but at the time I could not remember the date attached to them. May I therefore inform you that my letter to Mr Manzie of the Department of Industry was dated 18 December 1980 and the paper entitled, "The Guangdong Project" also dated 18 December 1980 was marked "second draft".

I would be grateful if you would look at the letter and paper together. In particular, I would very much regret it if you saw only the paper and not the covering letter because the latter describes rather carefully the circumstances and short notice at which the paper was prepared.

Within a day or so I should have the considered reactions of the nuclear industry to what I have written and I think it would be worthwhile our having a word together later this week to see if their comments in any way change the sense of the arguments I have set out in my paper.

Yours sincerely



W Marshall



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Mike Patton

we spoke.

With the Compliments of

the

Secretary of State

5/1

United Kingdom Atomic Energy Authority

11 Charles II Street
London SW1Y 4QP

From the Deputy Chairman
Dr W Marshall, CBE, FRS

Telephone: 01-930 5454

17.9 DEC

Mr. [unclear] [unclear]

18 December 1980

Mr G Manzie
Department of Industry
Ashdown House
123 Victoria Street
London SW1E 6RB

cc W. Tucker, A. [unclear]
W. Alan [unclear]
FC's

Dear Gordon

I am not sure why you are in a hurry to make this submission to Ministers tonight, but I assume you have got good reasons for it. The attached paper setting out my views is not as polished as I would like it to be, but it is the best I can do within the deadline you gave me. I have been able to discuss it with Ned Franklin and Jim Stewart and have modified it in minor ways they suggested. They have not yet had a chance to discuss it with Rooney. I have not had a chance yet to discuss this paper with BNFL or Weinstock. I have, however, talked with Lord Weinstock today and he tells me that he has not been consulted on your proposal to approach the French now and therefore he has no opinion on it. He volunteered that when he saw the British Ambassador in Paris a few days ago he told the Ambassador that a UK approach to France at this point in time would be premature. I have also spoken today to BNFL and they have authorised me to say that they as a Company are also opposed to an approach to the French now.

Therefore, I would be grateful if you would put at the end of your recommendation a paragraph which reads as follows.

"This recommendation has been agreed interdepartmentally, after receiving advice from Hong Kong and Peking. We have not had time to discuss the paper with people outside the Departments, but the broad sense of our conclusion, that we should approach the French now, has been conveyed to a number of people. Dr Marshall of the UKAEA, Dr Franklin of NNC, and BNFL are opposed to this recommendation. Lord Weinstock has not been consulted and therefore has no view one way or the other."

I am sure you will realise that you will put me in an impossible position if this point is not made clearly to Ministers and I would be grateful, therefore, if you would confirm that a paragraph along these lines has been included in your paper. May I also ask you to verify my account of other peoples' opinions. It is always possible that I have misunderstood them and therefore it would really be best if you consulted them directly.

Cont'd ...

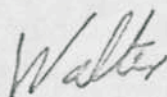
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18th December 1980

Incidentally, Abouardham has requested a meeting with me when I take my Pressure Vessel Study Group to Framatome on 19th January. In my view, if we are to have discussions with the French it would be much better for them to arise naturally in that kind of way, rather than as a result of an official delegation to Paris, but that, of course, is a decision you must make.

I appreciate that this letter will set you some problems and I give you my most grovelling apologies for being difficult. However, I have an absolute duty to keep you informed of my own opinions and of the opinions of other people in the business, in so far as I can establish them, in the brief time you have given me. I would have much preferred to have consulted all the organisations carefully on the attached paper and given you our collective judgement on the matter. I am also very conscious that my consultations with them today have been on the basis of the brief telephone message you were good enough to give me yesterday. None of us have seen your submission and, therefore, we are unable to judge the force of the argument that we should approach the French now. It is a great pity that you are obliged to take action without yourself first carefully consulting the industries involved.

Yours sincerely



W Marshall

Att

PS I have marked this letter "First Draft" because I am have inadvertently misrepresented the views of the people I have talked to and therefore I want to give them all a chance to comment before finalising it. That is unsatisfactory but it is the only thing I can do at 24 hours notice.

18 December 1980

The Guangdong Project

The purpose of this note is to set out my thinking on this project so that the Department of Industry can take account of that in deciding how to proceed further with this project.

At the meeting in the Department of Industry chaired by Mr Manzie on 20 November, I gave a report on my first discussion with Lu Ying and Mr Davidson gave a report on the discussions GEC had had with both Framatome and Westinghouse. That meeting was not attempting to make decisions but the consensus view at that time appeared to be that we should keep our options open for working either with Westinghouse or Framatome. Since that time there has been a sharp shift of opinion in favour of working with the French and further arguments have been put forward that we should make a deal with the French, now, that they should provide the nuclear island and that we should provide the conventional plant. I still have modest reservations about working with the French and serious reservations about making a deal now but I recognise the content and force of the unanimous decision of Government departments to the opposite sense. It would, therefore, be unrealistic of me to oppose this course of action but, for the sake of the record, I would like to set out my analysis as I see it today so that my point of view can be understood. I hope, anyway, that it will be helpful whatever course of action we take.

This is an exceedingly complex project with many ideas interwoven one with another. I shall, therefore, set out various considerations under the following sub-headings: Technical; Safety; Equity; Security of Supply; Chinese Attitudes; CLP Attitudes; French Attitudes; Westinghouse Attitudes; Financial Assessment; Recommendations and Position of the UKAEA.

Technical

For the purpose of this discussion the technical content of the project can be summarised by reference to Table 1 which divides work under the headings of "nuclear plant", "conventional plant", "civil work", "architect/engineer" and "fuel supply". The nuclear island is further sub-divided into NSSS and the balance of nuclear plant (BONP). The fuel supply is further sub-divided into

the first core, reload fuel for the first 10 years and reload fuel for the following 20 years. Against each heading I have given a rough estimate of the value of the work in two columns; first the value of the work to the western contractor and the second the value of the work which necessarily must be performed inside China. The right hand side of the Table shows the possible suppliers of each item. This list of possible suppliers is not, of course, exhaustive. Thus, for example, as possible architect/engineers I have listed only Electricite de France, NNC, Bechtel and a consortium of NNC plus Bechtel. An exhaustive list would, of course, add KWU, Stone and Webster, Gibbs and Hill etc.

A more detailed breakdown of the equipment and its value is shown in Table 2 where against each item of equipment there is shown the possible French supplier, the possible UK supplier and an indication is also given of those components which can be supplied by Westinghouse directly.

The joint utilities CLP and KEC have already decided that they will not place a complete turnkey contract for the entire station and neither will they adopt an "American" style of operation of appointing an architect/engineer and leaving it to him to place a large number of individual small contracts on other companies. Roughly speaking, therefore, we can assume that the project will be divided up into something like this set of packages. A key issue is whether the project will place a contract for the nuclear island as a whole or just for the NSSS. From the presentations which the reactor vendors made in Guangdong, we note that Framatome and KWU would prefer to have a contract for the nuclear island as a whole whereas Westinghouse would prefer to have a contract for the NSSS alone. It is also important to consider how far the civil work can or should be separated from the provision of other plant but that is a matter to which I have not yet given any thought.

The NSSS must be manufactured in special purpose factories in the USA, France, Germany, Italy or Japan but at the level of this discussion we may assume that all NSSS supplies are technically equivalent.

The balance of nuclear plant consists of conventional hardware such as small diameter pipes (about 20 miles of it), water tanks of various types and ECCS pumps. In contrast to the NSSS, there is nothing special about this

hardware and it can be provided from almost any country including the UK. The unique feature of the BONP is not the hardware but the system of design and control with which it is put together. This is normally done by an architect/engineer working in close collaboration with the NSSS supplier. It is the BONP that determines the safety characteristics of the plant and, roughly speaking, it is the BONP that varies from one country to another depending on the safety regulations prevalent in any particular country.

In the supply of conventional plant a key question of some controversy is whether the turbines should operate at high or low speed. In their presentation in Guangdong, GEC recommended high speed turbines. The Chinese reaction to the GEC presentation was hostile and quite out of keeping with the technical discussion. I assume it was stimulated by some aspect of internal Chinese politics we do not yet understand.

The civil work to be undertaken by China is a matter of some concern. We have no evidence that China can organise itself to produce this civil work on time and to quality.

So far as the architect/engineer is concerned, I am doubtful if Electricite de France would want to undertake the work. They are very busy with their own domestic programme and they would not want to get involved in any discussions which concern a BONP to meet different safety standards (because that would reflect upon their domestic decisions). This is what Abouadarham has told me informally and in apparent confirmation of this, Framatome have told Kadoorie that if they had the contract for the nuclear island, they would employ Bechtel as their architect/engineer partner. However, these views should be treated with caution; if the French get the business they will surely think this out again and may decide this must have a French architect/engineer because of the key and central role an architect/engineer plays in a nuclear project.

NNC standing alone is not a credible architect/engineer because of their inexperience with PWRs. Obviously Bechtel standing alone is a credible architect/engineer. Bechtel and NNC working in a joint venture would have the advantage of using an experienced architect/engineer (Bechtel) with an input from NNC about the capability of British manufacturers.

The value of the fuel contracts are substantial. We surely must try to secure those.

Safety

In discussing this subject it is very important to make a distinction between three possible questions.

1. What is the risk of a nuclear power station to Hong Kong?
2. Is the reactor design sufficiently safe?
3. Does the reactor design meet British, ie NII, guidelines?

For all conceivable reactor designs the risk to Hong Kong is entirely negligible. That as a real question may, therefore, be ignored. In my opinion all reactor designs which are likely to be offered to this project are sufficiently safe and there is no significant difference between them from this point of view. Both of these points are, however, a statement of my personal opinion, both statements would be disputed by the anti-nuclear groups which are active throughout the world, and it is unfortunately true that the general public in most countries are afraid of nuclear power. It is therefore worth asking the third question which is both narrower and more precise.

Earlier this year, Kadoorie made a statement to the joint project that he would be unable to participate in any project which did not meet the UK guidelines fully. At the time I advised him that this was a more extreme statement than was justified by the facts but he nevertheless felt as a matter of principle he must argue for UK guidelines on safety. That decision, which he has held to consistently (until very recently) has guided much of my thinking on this project.

If the reactor is to be built to UK safety guidelines then, in my judgement, it is easier to accept a KWU reactor or a Westinghouse reactor than a Framatome reactor. I always anticipated some difficulties in reconciling Kadoorie's position on safety standards and the possibility of a French nuclear island. That difficulty has recently been enhanced. NNC has nearly finished its design consideration of the PWR to be built in the UK and the safety provisions are substantially different from PWRs which have been built in the past. All the changes lie in the BONP. The NNC design has been reviewed by Westinghouse who have indicated that they will be obliged to build similar reactors in the USA in order to recapture public confidence after Three Mile Island. This last point

must be confirmed with Westinghouse and a formal discussion is planned between NN and Westinghouse for early next year. In my opinion, the Germans will be obliged by German Law to modify their designs to a similar level and, at that point, there will be a broad international consensus on the "post-TMI design of PWRs". That design will show considerable differences from the present French BONP. To explain these developments in detail I append to this note a record I made on 26 November concerning the NNC/Westinghouse/Bechtel conclusions on the BONP.

Therefore, if we are to use a French reactor we have only the following choices.

1. To have them build only the NSSS.
2. To have them build the entire nuclear island and abandon our application of British safety guidelines,
- or,
3. have them build the nuclear island but impose on them a BONP which is consistent with the new NNC design.

This last solution would be rather uncomfortable and difficult to negotiate. Last Friday I explained these three choices to Kadoorie and he immediately elected for the second choice. This was a surprise to me because he had previously consistently argued for the application of British safety guidelines. I accept that if those are now to be abandoned the argument for the French providing the entire nuclear island is strengthened. I have previously argued very strongly against having a French nuclear island. I acknowledge that this recent decision by Kadoorie, which needs to be confirmed in writing, annihilates much of my previous argument and I am reduced to the plea that we will get more work for the UK if our partner is Westinghouse than if our partner is Framatome.

Equity

The Chinese proposed to finance the project 90% by loans 10% by equity. Sixty per cent of the equity, ie 6% of the money, would be provided by internal effort within China and 40% of the equity, ie 4% of the expenditure, would be provided from outside China. The original intention was that 4% would be provided by CLP. When Kadoorie decided not to do this - presumably for fear of nationalisation - the Chinese were bitterly disappointed and clearly upset. However, they appear to have accepted the idea that there should be set up a Hong Kong Nuclear Investment Company (HKNIC) which would provide 4% of the money

required. The Chinese have said that they would welcome it if this equity were provided from the UK and it would be even better if it would come from the UK Government. Because they appear to attach importance to this matter I have, on a personal basis, suggested that this equity be taken up by the Atomic Energy Authority, or some similar Government body or consortium, but of course I have carefully qualified this proposal to ensure that it is not taken up unless the UK get the bulk of the project.

If the UK were to take up equity, I shall assume that it would be done by a consortium of AEA, BNFL, CEGB, NNC and GEC.

There are several features of this equity position which puzzle me. I do not really know why the Chinese want it. It cannot be for financial reasons because 4% of the money is so tiny and conceding 40% of the equity to the UK Government would, in my opinion, be a sizeable sacrifice of Chinese freedom of action. If we did have 40% of the equity the decisions on contractors would be heavily determined by us and the bulk of the contract would then be British. That is why, in my opinion, such an equity position is attractive to us. My own opinion therefore is that the Chinese will not follow this idea up unless they see political advantage to it, or unless there is some argument in favour of it which I have not yet seen but which presumably is connected with internal Chinese affairs.

The second feature of the equity argument which is strange to me is the proposal being made by Kadoorie that in HKNIC the voting rights should be weighted to give CLP control, although they only buy 10% of the HKNIC shares. Furthermore, Kadoorie is proposing that HKNIC and KEC, having set up the Guangdong nuclear project with a 60:40 equity ratio in favour of the Chinese, should promptly set up a Project Management Company consisting of KEC and CLP with a 50:50 equity ratio to do all the work. This in effect gives CLP 50% of the decision making, ie veto power, for 4% of the equity contribution. I am surprised that any commercial concern would want to contribute to HKNIC in these circumstances. I am sure that the British Government would not want to do so.

My present position on equity is that I would recommend the British Government, acting through a technical consortium, should take equity if such a decision would give us a UK led package with everything provided from the UK except the NSSS and provided that the equity participation was real, ie not symbolic as

liability?

Kadoorie is at present planning. However, I would not recommend that the British Government should take equity if we provided only the conventional plant or if HKNIC were insulated from decision taking as Kadoorie is at present planning.

Security of Supply

China and Hong Kong both have an interest in having a secure supply of electricity and this means getting a secure supply of fuel to the reactor. To guard against political upsets in the future this must therefore involve BNFL. We ought to make an argument therefore that BNFL should provide all the reload fuel and possibly the first charge as well, but a counter-argument can well be that a secure supply of fuel is assured providing that BNFL exist and that therefore all that needs to be established is that they are capable of supplying the fuel, not that they would actually provide it. The French will deploy this argument very strongly but, because of the history of American instability in this field, Westinghouse's objectives would be more muted.

No -
only if they
can
supply it

Chinese Attitudes

It is only through involvement in this project that I have come to appreciate the obscure nature of the oriental mind. I cannot hope to interpret Chinese attitudes properly. I can only note what I have heard from them, note the comments our China experts have made and think how I would react if I were in the Chinese position at this point in time.

In my view the dominant Chinese thought at the moment might well be that they wish to keep their options open. They would like to keep a set of opportunities, hopefully competing opportunities, which would enable them to pick and choose what suits them best. Having already received a turnkey French offer for the Shanghai project, I think that they may have received a turnkey French offer for South China as well. Even if this is not the case the Shanghai bid would no doubt have been regularly up-dated by the French and serve the same purpose. Surely they will want to see what other proposals they can get and then play off one "supplicant" against another. I assume that KWU can be eliminated from the race for political reasons. They have told me that they are not mounting any sales effort in China and certainly they have such a low profile that their presence is not actually discernable. I assume that the Japanese can be eliminated

following the disastrous Chinese experience with them at their steel plant. This means that the only other plausible alternatives that the Chinese can develop are a French/UK proposal, a Westinghouse proposal and a Westinghouse/UK proposal. The proposals involving Westinghouse are entirely dependent on the attitudes of the new Reagan proliferation. Lu Ying has given me very positive encouragement to explore the American position. He has got Deputy Governor Wang to say very clearly that the Chinese will take a long time to make up their minds and this gives us time to explore the American position. All this encourages me to think that the Chinese have not actually made up their minds in favour of the French and would not take seriously an all French proposal at this moment in time. They appear to be in a hurry, but as best I can judge they give higher weight to exploring the American option.

Of course the fact that the Chinese want the American option to be explored does not necessarily mean that we should do so, but because a UK/Westinghouse package would be advantageous to us, it is my opinion that we should take time to do this before we get committed either way.

CLP Attitudes

Both Sir Lawrence Kadoorie and Sir Sydney Gordon appear now to have made up their minds that it would be best to get a nuclear island from France. Simultaneously they expressed doubt whether GEC can be the chosen supplier of the turbines. I can see that this point of view might well be in the best commercial interests of CLP. However, in my opinion, it is not in the best commercial interests of the UK to concede a nuclear island to France, and to leave the turbine decision to the later decision process (which Kadoorie has described to us) seems to me most unwise. I have explained to Kadoorie that a French nuclear island could not easily be reconciled to British safety guidelines. He has replied that in that circumstance he is now prepared to abandon the latter.

French Attitudes

I am sure the French would best prefer to get a complete turnkey contract. I think they may well have made that offer for South China as well as Shanghai, but if so I think the Chinese have rejected it, either because it would be unrealistic to exclude the British altogether or because it was premature. As a fallback position the French would like to provide the nuclear island and concede the conventional plant to us. They have indicated therefore that they would be willing to agree with us a plan in which they provide the nuclear island

with all the fuel and we provide all the conventional equipment. They would see to this but they would, of course, do their best to erode our participation in time and we may or may not be able to negotiate a secure fraction of the work.

Westinghouse Attitudes

The ambitions of Westinghouse are limited to providing the NSSS and the first charge of fuel. That limited ambition of course fits in very elegantly to UK ambitions to provide more plant. Westinghouse, Bechtel and NNC are already close associates in the UK PWR. The same composition with a different weighting of responsibilities would be very suitable for the China project. This combination would be even more suitable if we were to persuade the joint utilities to go for 4-loop plants rather than 3-loop plants.

Financial Assessment

I have previously argued, and still favour, a British led package sub-contracting the NSSS to either Westinghouse or Framatome and relying upon Bechtel to work with NNC as the architect/engineer. From Tables 1 and 2 we can assess the equipment and fuel value to the UK on this scheme as the following.

BONP	\$263
conventional plant	\$323
architect/engineer services	?
first fuel charge	\$195.6
reload fuel for 10 yrs	\$652.0
reload fuel for following 20 yrs	<u>\$1304.0</u>
Total	\$2737.6

If we follow the alternative of offering the nuclear island to the French then, for obvious technical reasons, this will be a French led project. The French will argue, and will succeed in arguing, that BNFL should have only a reserve position in the supply of fuel and they will therefore get the entire fuel contract. We would therefore, at best, get the conventional equipment. But in view of the antagonism to GEC which has been displayed by the Chinese and which I do not fully understand and given the French reputation for being difficult people to work with, I think there is a very fair chance that that will slip away also. This route, therefore, gives us a doubtful figure of \$323M. The

difference between these two figures is so stark that I could not myself make a recommendation to the British Government that we should seek a French package although I would not have the courage to oppose it if mine were the sole voice doing so.

Recommendations

Despite the formidable array of departmental opinion that we should make a deal with the French now, it remains my view that we should pursue simultaneously the UK/Framatome project and the UK/Westinghouse project. We should keep both on the string and decide between them later. If we proceed in this way we will inhibit Framatome and Westinghouse from making a turnkey offer. But this policy only makes sense if we can be sure that the American proliferation position will change under Reagan and the Chinese will wait until that has happened. All the information I receive from the Reagan transition team is that US proliferation policy will change and there are some guesses that the new President will announce on 20 January an intent to do so. My best judgment is that the policy will change but there will be no announcement on 20 January (except of a vague kind) because how can Reagan announce "a change" without defining "a change to". Nevertheless, in my view the new administration will also have China high on its priority list and I therefore think there is a good chance that proliferation difficulties on this project can be rapidly resolved, particularly if the project is a joint British/American affair. It is also my opinion that, if we make an immediate deal with the French now, Westinghouse will get the immediate sympathy of the new administration and will be empowered to make a major sales pitch to the Chinese. Whatever happens it will, of course, take at least six months and possibly a year for the new American position to emerge formally. However, the Americans will be able to do sufficient in informal discussions with the Chinese to capture their attention.

For these reasons I would recommend that NNC should make an immediate agreement with Bechtel that whatever happens they will find a way of working together on this China project. We should then tell both Framatome and Westinghouse that we will be willing to work with either of them in either a UK/Framatome or a UK/Westinghouse package and that the decision between those two options will be a political one made by the Chinese. If it is assumed that

both Westinghouse and Framatome believe we have a favoured position there is chance that they will compete for the privilege of being our partner and that is the type of competition I would like to see in this project.

If, despite these arguments, it is decided to make an approach to the French now, please let us not concede immediately that they are to provide the nuclear island and all the fuel since that gives them a wonderful basis from which to erode our conventional island. Let us instead offer them a NSSS and the first charge of fuel and claim everything else for ourselves. I have every confidence that later negotiations will erode our participation to a more modest level.

Position of the UKAEA

As this project evolves we need to keep under review the role of the UKAEA. At the moment we are servicing as advisors to Kadoorie, advisors to the Hong Kong Government and a servant to the Department of Industry. There are some conflicts between those three roles. Those conflicts are not acute at the moment but they will grow in time. If we now decide to go for a French nuclear island it would be very uncomfortable for the UKAEA to be safety adviser to Kadoorie. When the NNC design becomes public knowledge, and the approval of Westinghouse is clear, there are certain to be some questions and probably some controversy about the French designs. Quite apart from the NNC developments, there are genuine doubts about the seismic design of the French reactor. (I think the Chinese technical people realise this.) I therefore think the French safety people are a more appropriate group than the UKAEA to defend the French position. Personally I do not wish to get into a position where I am defending an NNC design in the UK and a French design in China. I think, therefore, that at the appropriate moment in 1981 the UKAEA ought to withdraw from this project if we follow the French route. So far as advice to the Hong Kong Government is concerned, this could be done equally well either by the AEA, the NRPE or the French.

TABLE 1

<u>NUCLEAR ISLAND</u>	(NSSS	\$366M	Westinghouse (USA) Westinghouse (Europe) Framatome (France) Breda (Italy) GHH (Germany)	
	(BALANCE OF NUCLEAR PLANT	\$263M	USA France UK	
<u>CONVENTIONAL</u>	(TURBINE GENERATOR	\$323M	GEC Alstrom etc	
	(STEAM EQUIPMENT			
	CIVIL WORK		China	
	ARCHITECT ENGINEER		Electricite de France /Bechtel NNC NNC plus Bechtel	
<u>FUEL</u>	(FIRST CORE	\$2151.6M	Westinghouse Cogema (France) BNFL (UK)	
	(RELOAD FOR 10 YRS			"
	(RELOAD FOR 20 YRS			"

TABLE 2

Break-down of the Proposed Nuclear Power Plants in Guangdong into Principal Items of Equipment and Design, Construction and Management Tasks
with Cost Estimates and Possible Contractors

(The overall cost is comparable with the KEC/CLP Joint Feasibility Study. The breakdown of equipment costs is based on the paper by J.A. Richardson, 'Summary of Current (1978-79) US Total Cost Projections for 1200 MW(e) PWR Power Plants'. Costs are expressed in 1980 US dollars and are based on two 900 MW(e) stations.)

Item of Equipment or Expenditure	Approximate cost 1980 US\$ x 10 ⁶	Fractional cost (% of total equipment cost)	Possible French Contractor	Possible UK Contractor	Possible Supply by Westinghouse
<u>NUCLEAR ISLANDS</u>					
<u>Nuclear Steam Supply Systems</u>					
Reactor pressure vessels	45	4.7	Creusot-Loire	-	-
Vessel internals	40	4.2	Creusot-Loire	Fairey Engineering GEC Vickers	-
Control rods and drive mechanisms	25	2.6	Alsthom-Atlantique	GEC	Yes
Steam generators [tubing]	85	8.9	Creusot-Loire [Vallourec]	(Foster Wheeler) [Tube investments Accles & Pollock]	-
Coolant pumps	30	3.2	Jeumont-Schneider	-	-
Pressurisers	20	2.1	Framatome	Babcock Int. Clarke Chapman Foster Wheeler	Yes
Main coolant piping	15	1.6	SPIE-Batignolles	Cameron Iron Works	-
Emergency core cooling system accumulators	30	3.2	Creusot-Loire	Babcock Int.	-
high head injection pumps			EIS Pompes Guinard	Weir	-
low head injection pumps			EIS Pompes Guinard	Stone-Platt	-
water storage tanks			Bignier Schmidt-Laurent	Head Wrightsons	-
heat exchangers			Framatome	Whessoe	-
chemical and volume control system, residual heat removal system	30	3.2	Framatome	GEC	-
<u>*** Shell and Structure of Nuclear Plant</u>					
Steel liner of containment building	37	3.9	Creusot-Loire	Braithwaite McAlpine	-

Polar crane	1.6	0.2	Atelier at Chantier, CFEM	Taylor Woodrow Whessoe Carruthers Warton	-
Emergency diesel generators	7.8	0.8	Alsthom-Atlantique Robatel	GEC	Yes
Containment penetrations	5.8	0.6	Alsthom-Atlantique	GEC	Yes
Structural steel	14.7	1.5	CFEM		Yes
Refuelling water storage tank	1.9	0.2	Pechiney Ugine Kuhlmann Bignier Schmidt-Laurent	Babcock Int. NEI	Yes
Spent fuel storage racks	1.3	0.1	Bignier Schmidt-Laurent	Fairey GEC	Yes
Auxiliary feedwater system	1.35	0.1	Alsthom-Atlantique	GEC	-
Spent fuel flask crane	1.5	0.2		Carruther Warton	-
Hydrogen recombiners	0.9	0.1		Johnson-Matthey	Yes
Heating, ventilation and air conditioning equipment	4.2	0.4		GEC	-
Sump pumps	3.2	0.3		Stone-Platt	-
Containment spray system	1.0	0.1		GEC	-
Component cooling water system	2.3	0.2		GEC	-
Main steam isolation valves	1.7	0.2	Velan	Hopkinsons	-
Piping	17.2	1.8	SPIE-Batignolles	GEC	-
Electric cable	8.6	0.9	Jeumont-Schneider Pechiney Ugine Kuhlmann	BICC	Yes
Safety related switchgear	0.8	0.1	Alsthom-Atlantique	GEC	-
Valves	19.5	2.1	Rateau-Velan Sereg & Gachot Bouvier-Darling	Reyrolle Parsons Hopkinsons Crosby Rotork Newman Hattersley	Yes
Electric motors and controls	2.4	0.3	Alsthom-Atlantique Jeumont-Schneider	GEC	Yes
Safety related panels in Control Room	1.3	0.1	Alsthom-Atlantique	GEC	Yes
Essential AC power supply	1.0	0.1	Alsthom-Atlantique	GEC	-
Fire protection equipment	6.7	0.7		Chubb	-
Cable trays and conduit	1.2	0.1		BICC	Yes
Reinforcing steel for concrete	47.5	5.0			-
Radioactive waste treatment plant	71.2	7.5	Alsthom-Atlantique Atelier et Chantier	GEC	Yes

**Control panel and protection system

49

5.6

Alsthom-Atlantique

GEC

Yes

TABLE 2 continued

Break-down of the Proposed Nuclear Power Plants in Guangdong into Principal Items of Equipment and Design, Construction and Management Tasks
with Cost Estimates and Possible Contractors

Item of Equipment or Expenditure	Approximate cost 1980 US\$ x 10 ⁶	Fractional cost (% of total equipment cost)	Possible French Contractor	Possible UK Contractor	Possible Supply by Westinghouse
<u>TURBINE ISLAND</u>					
<u>Turbine-Generator Plant</u>					
Turbine-generator)	204.3	21.5	Alsthom-Atlantique	GEC	Yes
)				NEI Parsons	
Moisture separator/reheaters)				GEC	
Main steam piping)				GEC	
Lubrication system for turbine)				GEC	
Cooling system for generator)				GEC	
Control panel)				GEC	
<u>Balance of Plant</u>					
Electrical distribution yard	2.1	0.2		GEC	-
Sea water circulating pumps	2.2	0.2	Alsthom-Atlantique	Weir	-
Main condensers	4.9	0.5	Alsthom-Atlantique	GEC	-
Condenser tubing (aluminium bronze) (titanium)	8.9	0.9			-
Feedwater heaters	7.3	0.8	Alsthom-Atlantique	GEC	-
Condensate extraction pumps	0.9	0.1	ETS Pompes Guinard	Weir	-
Boiler feed pumps	1.7	0.2	ETS Pompes Guinard	Weir	-
Feedwater heat drain pumps	0.6	0.1	ETS Pompes Guinard	Stone-Platt	-
Instrumentation and station compressed air supply	0.2	0.0		GEC	-
Concrete piping for seawater flow	1.4	0.1		Taylor Woodrow	-
Crane for turbine hall	2.8	0.3	Neypric	Carruthers Warton	-
Station switchgear	9.1	1.0	Alsthom-Atlantique	GEC	-
Secondary plant cooling system	1.2	0.1		GEC	-
DC standby power supply	0.4	0.0		GEC	-
Air extraction system for condenser	0.5	0.1		GEC	-
Lifts for personnel and equipment	0.6	0.1			-
Chlorination equipment for seawater flow	0.1	0.0			-
Condensate polishing plant	0.2	0.0	Alsthom-Atlantique	GEC	-
Maintenance supply system	1.1	0.1	Alsthom-Atlantique	GEC	-

Water storage tanks	3.0	0.3		Babcock	Yes
Piping	10.2	1.1		Babcock	-
Valves	13.5	1.4	Alsthom-Atlantique Gachot	Hopkinsons Crosby Rotork Newman Hattersley	Yes
Electric motors and controls	2.0	0.2	Alsthom-Atlantique	GEC	Yes
Electrical cable	6.1	0.6		BICC	Yes
Structural steel	35.5	3.7	CFEM		-
Cable trays	1.0	0.1		BICC	Yes
<u>OTHER MAJOR ITEMS OF EXPENDITURE</u>					
Civil construction work	309.5			McAlpine Taylor Woodrow	-
Project design)			Edf, Bechtel	NNC Bechtel	Yes
Construction management)	153.0		Framatome	NNC	-
Quality assurance)			CERCA, CFEM Framatome	GEC NNC	Yes
Project management	67.9		CFEM, Framatome	NNC GEC	-
Plant erection	95.2			Each contractor	-
Supply of specialists	69.0		Framatome	UKAEA NNC GEC	Yes
Spares)				Various	Yes
Training)	67.0			CEGB	Yes
Insurance)					
Contingencies	85.0			-	
<u>FUEL</u>					
Initial charge	195.6		FBFC	BNFL	Yes
Replacement fuel for 10 years	652.0		FBFC	BNFL	Yes
Replacement fuel for 20 years	1304.0		FBFC	BNFL	Yes
<u>Transmission lines</u>	240.0				

NOTE FOR THE RECORD

Developments in the Design and Safety Analysis of the first PWR in the UK

1. At the meeting of the Nuclear Industry Group on 25 November 1980 a presentation was made by NPC on the recent developments in the design and safety analysis of the Sizewell PWR. This note summarises the main developments as I see them.
2. In May 1980, NPC selected the Callaway I plant as the basis for the NSSS design for the UK plant. Callaway I is a Westinghouse 4 loop plant producing 3425 MW (thermal) and is due to start operation in 1982. It has type F steam generators and a single 1800 rpm turbine-generator.
3. To make use of current UK experience with the turbine-generator manufacture, the UK plant will use two 600 MW turbine-generators.
4. The safety philosophy adopted in the UK and set out in the CEBB design guidelines requires additional safety features to those currently employed in the USA. In particular, there is a need for increased plant redundancy. Having carried out a probability analysis of existing plant designs, NPC have come to the opinion that a 4 train ECCS is required. (Most PWR plant in the USA have a 2 train system.) The need for a 4 train system is now accepted by Westinghouse and Bechtel. In addition to redundancy, there is also a requirement for the use of diverse equipment with independent back-up on all essential safety systems.
5. Having made the decision to adopt a 4 train ECCS, the layout of the nuclear plant must be changed. In particular, the four trains will be spread all the way around the main containment instead of only around one half. An access route for bringing heavy equipment into the containment must be provided but the details of this are not settled.
6. An additional requirement for the UK plant is the reduction of radiological exposure for operating personnel. The CEBB requirement sets a maximum total annual dose of 0.2 man-rem/MW(e), (ie 240 man-rem for the proposed station). This dose is half the best dose achieved so far in any US plant and one sixth the average US dose. (The average dose in Europe for plants recently commissioned is in the range 300-400 man-rem.)
7. To achieve the required reduction in man-rem, NPC are proposing:
 - a) additional space for access to plant for inspection and maintenance
 - b) special equipment to reduce dose and exposure time (eg multi-stud tensioner for removing the RPV head bolts)
 - c) remote handling devices for routine inspections (eg non-destructive examinations - especially the steam generator)
 - d) decontamination areas for equipment and changing rooms for personnel within the containment.

8. It should be noted that the largest cause of occupational exposure in the US has been the examination and repair of the steam generators. If reliable operation of the steam generators can be achieved then a substantial fraction of the operator dose can be avoided.

9. Using the ideas described above, NPC have prepared an initial design which has been discussed with Westinghouse and Bechtel. Further discussions are now underway and Westinghouse are introducing new ideas from their own development work and safety analyses in the USA.

10. Specific topics in the joint discussions have included:

a) the use of deepwell pumps for safety duties. These pumps have vertical shafts with a top mounted motor. The vertical design gives better opportunity for providing inlet subcooling and reduces the required floor space.

b) the detailed layout of the containment to reduce operator dose

c) the necessity to depart from the SNUPPS layout because of the 4 train ECCS and the construction of the reactor on soft terrain

d) the detailed design of the containment including containment diameter, the roof design and the possibility of providing temporary access at ground level during construction. For the roof design, it was originally intended to use a flattened dome to reduce the containment volume but on advice from Westinghouse a hemispherical roof is now being considered.

11. As a result of safety assessments following the accident at Three Mile Island, Westinghouse have now made the following proposals:

a) deepwell pumps should be used for all safety related duties

b) the ECCS should be built entirely within the primary containment. (With present designs and in the event of an accident causing severe damage to the reactor core, highly active water will pass through the ECCS which is partially located outside the containment.)

12. NPC have accepted the logic of the Westinghouse suggestions and are now working on the engineering solution. In one possible design, the Refuelling Water Storage Tank (RWST) is moved inside the containment and located in the reactor sump. Since water for the ECCS is normally drawn initially from the RWST and later from the sump, by moving the RWST to the sump, change over valves can be eliminated. In the initial NPC design, there were two RWS tanks each supplying water to two of the four ECCS trains. It would therefore be necessary to provide two separate tanks in the sump to give the required redundancy.

13. Consideration had also been given to modifications to the proposed ECCS trains to reduce the space requirements within the containment. It was proposed to increase the capacity of the High Head Safety Injection pumps so that they could supply the required flowrate for longer into an accident. For longterm ECCS during an accident, the pumps for the Residual Heat Removal System would double as the Low Head Safety Injection pumps. For accidents, where the HHSI pumps could not supply sufficient flow, a new storage tank would be installed.

This tank would be filled with pressurised water and would be designed to inject water during the period when the flow from the HHSI pumps was insufficient. Even with these space reductions, the ECCS pumps cannot be accommodated within the circular containment building and it is proposed to build extensions to the containment to hold the pumps. These extensions will be designed to withstand full containment pressure during accidents but will be provided with man-access ways so that maintenance work can be carried out while the plant is in operation.

14. NPC are proposing to use a forged ring component for part of the shell of the steam generator to eliminate the welds at the change of section. It was pointed out during subsequent discussions at Harwell that the main, essential and back-up feedwater supplies all use the same nozzle on the steam generator. Thus, despite the diversity of feedwater supply, there is a possibility of common mode failure through damage to the single nozzles.

15. NPC have carried out a probabilistic assessment of Anticipated Transients Without Scram and have come to the view that this type of accident should be considered as a design fault. This will have serious implications for the design and safety analysis of the vessel. It will also mean that thermal-hydraulic assessments of ATWS events will be required.

16. In addition, NPC are now reconsidering a fast boration system. This system was initially designed to cope with accidents involving multiple steam line breaks but was set aside after discussions with Westinghouse. Fast boration does however offer a secondary shutdown mechanism to limit the risks of ATWS.

17. NPC are using the existing fault analysis as the basis for the UK Safety Case. They have however identified the need to carry out significant additional analyses to study.

- a) fault combinations identified by the UK probability approach
- b) sensitivities and margins to variations in plant behaviour and parameter assumptions.

It was felt that additional assistance from the AEA was required in this area.

18. Although it is the safety policy of NPC and CEGB to concentrate on preventing class 9 accidents rather than mitigating the consequences, it was felt that further attention needs to be paid to fission product release. This is in line with recent arguments put forward by Levenson in the USA.

19. I am impressed with the careful thought that NPC have put into these matters. I am obliged to accept the logic of all their arguments although it is disappointing that the BONP and the layout of the plant will be so different from any earlier Westinghouse or Framatome reactors. However, it is important to note the close agreement which has been reached between NPC, Westinghouse and Bechtel. It seems highly probable that when the Americans begin construction of reactors again, their reactors will look very much like this one. Obviously this design has been put together to meet the criteria of the NII and to look ahead to the new regulations that are likely to be introduced in America by the NRC. It would be disastrous if we over-simplified our own approach and halfway through construction the NRC introduced new regulations which, by "knock on" effect obliged us to make changes. I think also it is very important to note that the NSSS itself is a well-proven system. It is only the BONP which is being changed.

20. If we treat ATWAS as a design basis accident and the NRC make it a regulation in the near future, I think German law will compel KWU to follow suit. It is then fascinating to speculate how the French will react. They will still be mass-producing, using superb production engineering, a reactor whose design the rest of the world has decided is inadequate. As a side issue, it is also fascinating to speculate on the attitude of the Chinese when they understand all this. They will be torn between a desire to have a well-proven plant and a desire to have up-to-date technology.

W Marshall

26 November 1980

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so on the understanding that these talks would in no way commit the UK to participating in an Anglo-French package and that the possibility of proceeding with a British-led package including the supply of a Westinghouse reactor is kept fully open and will continue to be explored.

I should also like to emphasise the urgency of the approach to the Chinese authorities recommended at paragraph 21 (iii) of the official paper. In addition to firm information on the likely Chinese choice of reactor we also need a much clearer view of the realistic timescale for the project in order that I can better assess the role which the UK nuclear industry could play in the project.

I am copying this letter to the recipients of yours.

Yours ever

Dave

D A R HOWELL