

PCA Case No. 2023-01

IN THE MATTER OF AN ARBITRATION

-before-

THE COURT OF ARBITRATION CONSTITUTED  
IN ACCORDANCE WITH THE INDUS WATERS TREATY 1960

-between-

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

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CERTIFIED TRANSCRIPT  
(HEARING FOR THE FIRST PHASE ON THE MERITS)

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COURT OF ARBITRATION:

Professor Sean D. Murphy (Chairman)  
Professor Wouter Buytaert  
Mr. Jeffrey P. Minear  
Judge Awn Shawkat Al-Khasawneh  
Dr. Donald Blackmore

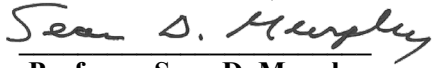
SECRETARIAT:

The Permanent Court of Arbitration

ON BEHALF OF THE COURT OF  
ARBITRATION:

CERTIFIED PURSUANT  
TO  
PARAGRAPH 19 OF ANNEXURE G

15 July 2024

  
Professor Sean D. Murphy  
Chairman

In the matter of an arbitration  
pursuant to Article IX and Annexure G  
of the Indus Waters Treaty 1960  
PCA Case No. 2023-01

Permanent Court of Arbitration  
Peace Palace  
The Hague  
The Netherlands

Day 6

Monday, 15 July 2024

Hearing of the First Phase on the Merits

Before:

PROFESSOR SEAN D MURPHY  
HE JUDGE AWN AL-KHASAWNEH  
DR DON BLACKMORE  
MR JEFFREY P MINEAR  
PROFESSOR WOUTER BUYTAERT

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BETWEEN:

THE ISLAMIC REPUBLIC OF PAKISTAN  
-and-  
THE REPUBLIC OF INDIA

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Transcript produced by Trevor McGowan  
Georgina Vaughn and Lisa Gulland

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<p>13:14 1 Monday, 15 July 2024 2 (2.07 pm) 3 THE CHAIRMAN: Okay. So we are in the second week of our 4 hearing, and this will be the second round of 5 submissions by Pakistan. 6 I hope that everyone had as good a weekend as 7 possible, recognising that that possibility may have 8 been diminished somewhat by the work you had before you, 9 which we can already see in some of the materials that 10 you've recently sent in our direction. 11 We also do have a notional sense of your timing for 12 the presentations today and tomorrow, and are very 13 grateful for receiving that. 14 So I see Sir Daniel at the podium. Are there any 15 matters we need to discuss before we perhaps launch in 16 on your opening submissions? 17 SIR DANIEL: Thank you, Mr Chairman. We hope you all had 18 a good weekend, perhaps free from the burdens of having 19 to go over transcript submissions. 20 There's just one housekeeping point, and that is 21 that on Day 2 of the hearing, Ms Rees-Evans referred, in 22 her answer to the Court's question regarding the 1948 23 water dispute, to a Pakistani publication of 1952 24 setting out Pakistan's position on the history of that 25 dispute. That's transcript Day 2 at page 26, line 24 to</p> <p style="text-align: center;">Page 1</p>	<p>14:09 1 scheme, just before the mid-afternoon coffee break 2 tomorrow. 3 But I have to say that so far, the best laid plans 4 in terms of timing have gone awry, both for our 5 inclination to try and develop responses to questions 6 from the microphone and also obviously your interest in 7 putting questions to us. So the timing will depend 8 a little bit on the questions that come. 9 I will take you through the scheme briefly to make 10 one or two comments so that you have a clearer sense of 11 how we propose to proceed. 12 As a preliminary point, Mr Chairman, on Friday when 13 we closed, you indicated that the Court would be handing 14 down questions, and indeed we got those on Saturday, as 15 proposed. And you indicated that a number of the 16 questions would be picking up questions that you had put 17 orally. We have seen that, and we have noted that in 18 fact in a number of cases we have answered those 19 questions, or at least addressed them fairly fully, in 20 the first-round submissions. 21 So where this is the case, what we propose to do -- 22 and I'll start this off, but all of my colleagues will 23 address this as we go through -- is we propose to 24 provide transcript references to the places in the 25 transcript where we addressed these points in the first</p> <p style="text-align: center;">Page 3</p>
<p>14:08 1 page 28, line 9. The correct exhibit reference for that 2 publication is P-0350. So that's just a transcript 3 correction: P-0350. 4 THE CHAIRMAN: Very good, thank you. 5 SIR DANIEL: No other housekeeping points from us. There 6 will, of course, be a number of them that come tomorrow. 7 I should say that we were expecting that the Federal 8 Secretary of the Ministry of Water Resources would in 9 fact be in the hearing today, but he was detained in 10 Islamabad unduly. We expect him to be arriving some 11 time this afternoon, so that he will be here for the 12 closing tomorrow. 13 THE CHAIRMAN: That's fine. 14 No housekeeping matters on our end. So if that's 15 the case, Sir Daniel, I invite you to commence with your 16 opening submissions. 17 SIR DANIEL: Thank you, Mr Chairman and members of the 18 Court. 19 (2.09 pm) 20 Second-Round Opening Statement on behalf of 21 the Islamic Republic of Pakistan 22 SIR DANIEL: You have before you the draft scheme of our 23 second-round submissions. And as you will see from 24 that, we do not expect to use all of the time available 25 to us, and we are likely to conclude, at least on this</p> <p style="text-align: center;">Page 2</p>	<p>14:11 1 round, and then we will add any additional observations 2 that may be appropriate. We don't propose to simply 3 repeat what we've said in the first round. 4 Following some brief comments on the scheme of our 5 submissions, which I will come to in just a moment, 6 I will turn to some brief -- not so brief now -- but 7 substantive remarks addressing the following written 8 questions in my opening presentation, and I will come 9 back to a number of the questions in my closing 10 presentation tomorrow. 11 So today, what you will be hearing from me is 12 a response to questions 3, 4(a) and 4(b), which in some 13 shape or form all deal with information-sharing. I will 14 then address question 6, on India's compliance with the 15 Kishenganga award; and question 13, on weaponisation. 16 In some cases, we've already responded to these 17 questions in a little bit of detail and so I will be 18 reasonably brief. But in some cases, for example on the 19 information-sharing, I think that there is a fair amount 20 to elaborate on. 21 I will also address in my opening remarks now, this 22 afternoon, Mr Chairman, your enquiry about a preliminary 23 partial award addressing question 35(a) -- and perhaps 24 other elements -- on a more expedited basis on the 25 ground, first, that such issues could be readily</p> <p style="text-align: center;">Page 4</p>

14:12 1 detached from other elements of the Court's enquiry; and  
 2 second, that it may indeed be helpful, for wider  
 3 reasons, for the party to have early clarity on these  
 4 issues.  
 5 Mr Chairman, members of the Court, I expect to be on  
 6 my feet for about 60 minutes. It probably won't be much  
 7 less; it could be a little bit longer, depending on your  
 8 questions. I will then hand on the baton to Mr Rae, who  
 9 will be followed in turn by Dr Morris; that's assuming  
 10 we get through Mr Rae's presentation in time, or  
 11 otherwise Dr Morris will split his presentation between  
 12 this afternoon and tomorrow.  
 13 Mr Rae will focus largely on addressing engineering  
 14 aspects of your question on pondage, to provide  
 15 an engineering foundation for the submissions that  
 16 Mr Miles will make tomorrow. Dr Morris will range  
 17 a little bit more widely across a number of your  
 18 questions that call for engineering input: notably,  
 19 those relating to sediment management, associated design  
 20 issues and the issue of weaponisation. Between them,  
 21 Mr Rae and Dr Morris expect to be on their feet for the  
 22 remainder of the afternoon.  
 23 On the schedule as planned, as you will see from the  
 24 handout, we anticipate having four substantive  
 25 presentations tomorrow, starting with Mr Fietta, who

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14:15 1 longer.  
 2 After the lunch break tomorrow, I will make some  
 3 closing observations addressing your questions 7(a) and  
 4 7(b), on issues concerning challenges to the competence  
 5 of the Neutral Expert. In fact, I think we've addressed  
 6 those at some length in the first round, so I'll just be  
 7 pulling some of the threads together. I will also  
 8 address question 8 and the first part of question 9,  
 9 which I think is divided into three sentences, but I'll  
 10 just address the first element that is concerning  
 11 Annexure E.  
 12 I will also address tomorrow in my closing,  
 13 Mr Chairman, your five-step scheme to this sequence for  
 14 applying sources of law and practices.  
 15 And then, Inshallah, we assume that Mr Syed Ali  
 16 Murtaza, the Federal Secretary of Pakistan's Ministry of  
 17 Water Resources, will be here, and he will close  
 18 Pakistan's case with some brief concluding observations  
 19 and a formal reading of Pakistan's final submissions.  
 20 So that's the scheme of what we propose over the  
 21 course of the next day and a half. You will see,  
 22 Mr Chairman, members of the Court, that we have some  
 23 contingency time built in, notably tomorrow afternoon.  
 24 So if timing begins to slip a little bit today or  
 25 tomorrow morning, we hope that we won't be unduly

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14:14 1 will address various issues concerning res judicata, but  
 2 with special focus on the binding effect of Court of  
 3 Arbitration awards and their underlying reasoning.  
 4 You didn't address particular written questions on  
 5 this aspect of our first-round submissions, but it was  
 6 a topic of some discussion across the Court last week,  
 7 and there are a number of points arising from that  
 8 discussion which we thought may be helpful to pick up in  
 9 connection with your question (a) in PO6. And we  
 10 anticipate that Mr Fietta will need around about  
 11 40 minutes.  
 12 Mr Fietta will be followed by Professor Webb, who  
 13 will again address outlets, spillways and power intakes.  
 14 We've taken it that the issues of treaty interpretation  
 15 are well embedded, if you like, in your consciousness,  
 16 and so we don't have a separate presentation on that.  
 17 Professor Webb anticipates needing about 45 minutes, but  
 18 that will again depend on the questions that you may  
 19 have.  
 20 She will be followed by Dr Miles, who will address  
 21 you on questions of pondage, building on Mr Rae's  
 22 submissions this afternoon. Dr Miles's scripted remarks  
 23 come in at about 75 minutes. But on the experience of  
 24 Friday, we expect that you are likely to have lots of  
 25 further questions for him, so this may run a little bit

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14:17 1 anxious about that, and that there will be lots of time  
 2 to make up ground.  
 3 So, Mr Chairman, members of the Court, with that,  
 4 I propose to turn to a number of your questions  
 5 concerning information-sharing. And I will address  
 6 question 3, question 4(a) and question 4(d), and I will  
 7 take those together. I know that they don't only  
 8 encompass information-sharing, but they usefully address  
 9 some of the same rubric.  
 10 Forgive me if at one or two points I'm going to  
 11 become just a little bit pedestrian about this, because  
 12 what I propose to do is to read into your transcript  
 13 record the transcript references for last week that  
 14 address these issues, so that when you come back to  
 15 refresh your minds on these points, you've got all of  
 16 those references there.  
 17 So by question 3, you asked:  
 18 "When specifically in the planning stage does the  
 19 information-sharing obligation under Article VII(2)  
 20 crystallize and what categories of information must be  
 21 exchanged to make the notification process meaningful?"  
 22 You will find elements of this question addressed at  
 23 the following transcript references, and I'll just go  
 24 through them quickly: Day 1, page 199, line 7 to  
 25 page 200, line 20; Day 2, page 21, line 11 to page 23,

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14:18 1 line 12; Day 5, page 225, line 4 to page 227, line 4;  
 2 and Day 5, page 253, line 21 to page 255, line 23.  
 3 Then by question 4(a), you asked whether "the  
 4 constraints that exist in the Treaty for the design of  
 5 a HEP establish an obligation on India when it selects  
 6 a site for a HEP"; and "If so, what is that obligation?"  
 7 Once again, you will find elements of this question  
 8 addressed at the following transcript references. There  
 9 are quite a number of them. Day 4, page 6, line 1 to  
 10 page 9, line 2; Day 4, page 113, line 8 to page 116,  
 11 line 3; Day 4, page 117, line 14 to page 121, line 16;  
 12 Day 4, page 123, lines 4-16; Day 4, page 176, line 7 to  
 13 page 177, line 3; Day 5, page 220, line 13 to page 221,  
 14 line 4; and Day 5, page 223, line 19 to page 224,  
 15 line 16.  
 16 I promise you there won't be too many more of these.  
 17 Finally, by question 4(d), you asked whether India  
 18 has "an obligation to provide Pakistan with  
 19 an opportunity to review site selection more than  
 20 six months in advance of the beginning of construction".  
 21 You will find elements of this question addressed at  
 22 the following transcript reference, and that's Day 5,  
 23 page 253, line 21 to page 255, line 23. So that's the  
 24 last of the transcript references, at least for now.  
 25 Taking these three questions together, let me start

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14:22 1 "sites", not just "works".  
 2 So in terms of the remit of the Commission,  
 3 it's focused on cooperation, information exchange,  
 4 facilitating tours of inspection in connection with the  
 5 works and the sites on the rivers.  
 6 I then come back to a provision that you will be  
 7 very familiar with, and that's Article VII,  
 8 paragraph (2), which we've looked at previously. The  
 9 article is headed "Future Co-operation". And you will,  
 10 I think, be very much aware that the notion of  
 11 cooperation and future cooperation is a leitmotif of the  
 12 Treaty and indeed is expressed in the preamble: the  
 13 "cooperative spirit" animating the parties is expressed  
 14 in the preamble.  
 15 I don't suggest that you call up Article VII,  
 16 paragraph (2); you will have the essence of it in your  
 17 recollection. But I will just go over a number of  
 18 elements of it.  
 19 As you will recall, the first sentence of  
 20 Article VII(2) provides that:  
 21 "If either Party plans ..."  
 22 I'm emphasising the word "plans" for the moment:  
 23 "If either Party plans to construct any engineering  
 24 work which would cause interference with the waters of  
 25 any of the Rivers and which, in its opinion, would

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14:20 1 with some overarching observations.  
 2 The first is that the Treaty contains a number of  
 3 information-sharing provisions.  
 4 Article VI contains detailed provisions on exchange  
 5 of data. This is focused largely on the exchange of  
 6 data relating to the hydrology of rivers and the  
 7 utilisation of the waters of those rivers. Now  
 8 Article VI is not directly relevant to the present  
 9 enquiry, but it is important, as you'll see in just  
 10 a moment. Article VI also begins to set the tone  
 11 regarding the Treaty's approach to information-sharing.  
 12 Article VIII -- skipping over Article VII for just  
 13 a moment -- Article VIII, which addresses the Permanent  
 14 Indus Commission, provides that the Commission is to  
 15 serve as the regular channel of communication with  
 16 respect to, inter alia, the furnishing or exchange of  
 17 information or data provided for in the Treaty. And  
 18 this article goes on to provide that the purpose and  
 19 functions of the Commission are to establish and  
 20 maintain cooperative arrangements and to promote  
 21 cooperation between the parties, including, amongst  
 22 other issues, in respect of facilitating tours of  
 23 inspection, the purpose of which is "ascertaining the  
 24 facts connected with those works or sites" on the  
 25 rivers. And I note here in particular the reference to

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14:23 1 affect the other Party materially, it shall notify the  
 2 other Party of its plans and shall supply such data  
 3 relating to the work as may be available and as would  
 4 enable the other Party to inform itself of the nature,  
 5 magnitude and effect of the work."  
 6 Now the reference here to "engineering work which  
 7 would cause interference with the waters" requires that  
 8 Article VII, paragraph (2) is read alongside the  
 9 definition of "interference with the waters" found in  
 10 Article I, paragraph (15) of the Treaty, to which I took  
 11 you last week. This provides, as you will recall, that  
 12 "interference with the waters" means:  
 13 "(a) Any act of withdrawal [from the waters]; or  
 14 (b) Any man-made obstruction to their flow which  
 15 causes a change in the volume ... of the daily flow of  
 16 the waters ..."  
 17 Reading this definition into Article VII(2) makes it  
 18 quite clear, in our submission, that the notification  
 19 and provision of data requirements of Article VII,  
 20 paragraph (2) are intended to apply from the moment that  
 21 a party "plans" to construct an engineering work. That  
 22 is the plain meaning of the words on the page.  
 23 It is also clear that the assessment of material  
 24 interference is not a matter that is left to the  
 25 planning party alone. This also emerges from the second

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14:25 1 paragraph of Article VII, paragraph (2), which I haven't  
 2 read to you, but with which you will be familiar.  
 3 I will come back to the relevance of this in just  
 4 a moment.  
 5 These information-sharing provisions in the  
 6 Treaty -- Article VI; Article VIII, which deals with the  
 7 role of the Commission; Article VII, which is the  
 8 substantive obligation to notify and share  
 9 information -- so these information-sharing provisions  
 10 in the Treaty itself are supplemented by more detailed  
 11 and specific exchange of information provisions in the  
 12 annexures. Now I don't propose to undertake a wider  
 13 review across all of the annexures, but you will find  
 14 information-sharing in a number of the annexures.  
 15 I propose, just for a moment, to focus on Annexure D.  
 16 Pakistan's Commissioner provided a detailed overview  
 17 of these information-sharing provisions in Annexure D in  
 18 his written statement and oral evidence; his written  
 19 statement being at Appendix B to Pakistan's Memorial.  
 20 As we have seen from his submissions and from your  
 21 review of Annexure D, Part 3 of Annexure D contains  
 22 detailed provisions regarding the communication of  
 23 information. For present purposes, the provisions of  
 24 paragraph 9 of Annexure D is the most important. This,  
 25 you will recall, provides that:

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1 the [design] of a HEP establish an obligation on India  
 2 when it selects a site for [the] HEP"; and "If so, what  
 3 is that obligation?"; and finally, whether India has  
 4 "an obligation to provide Pakistan [with an] opportunity  
 5 to review [the] site selection more than six months in  
 6 advance of the beginning of construction".  
 7 As an initial point, I note that Article VII(2) does  
 8 not specify the kind of information that must be shared.  
 9 Nor does it specify the point at which such information  
 10 must be shared. It is cast in general terms. And  
 11 therefore we are quite content to say that we cannot  
 12 read into Article VII(2), without more, an obligation  
 13 upon India to share, for example, site choice  
 14 information. So the language of Article VII(2) does not  
 15 say, "India, thou shalt share site information".  
 16 It doesn't do that, and it doesn't address timing.  
 17 This said, I note that Article VII(2) is a hard  
 18 obligation. It's not simply a hortatory obligation,  
 19 an exhortation to provide information. It provides, in  
 20 its black letter, that a party:  
 21 "... shall notify the other Party of its plans and  
 22 shall supply such data relating to the work as may be  
 23 available and as would enable the other Party to inform  
 24 itself of the nature, magnitude and effect of the work."  
 25 The second sentence of Article VII(2) similarly

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14:26 1 "... India shall, at least six months in advance of  
 2 the beginning of construction of river works connected  
 3 with the Plant, communicate to Pakistan, in writing, the  
 4 information specified in Appendix II to this Annexure."  
 5 And as Mr Shah addressed in his evidence on Monday,  
 6 Appendix II of Annexure D addresses five categories of  
 7 information that must be provided at this point, at the  
 8 paragraph 9 point, at least six months before the  
 9 beginning of construction of river works. And those  
 10 five categories of information are: first of all,  
 11 location of the plant; second, hydrologic data; third,  
 12 hydraulic data; fourth, particulars of design; and  
 13 fifth, other general information. And the purpose of  
 14 this information-sharing requirement is that it is  
 15 intended to provide information that will afford  
 16 Pakistan an opportunity to review and to raise any  
 17 objections that it may have.  
 18 So with these provisions in mind, I come to your  
 19 questions 3, 4(a) and 4(d). And just to summarise them  
 20 without going through the transcript references, these  
 21 ask: "When specifically in the planning stage does [the  
 22 information-sharing obligation under Article VII(2)]  
 23 crystallize and what categories of information must be  
 24 exchanged to make the notification process meaningful?";  
 25 whether "the constraints that exist in the Treaty for

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14:30 1 provides that:  
 2 "... the Party planning the work shall, on request,  
 3 supply the other Party with such data regarding the  
 4 nature, magnitude and effect ... of the work as may be  
 5 available."  
 6 So this is not, therefore, a provision that can  
 7 simply be dismissed or disregarded as non-substantive.  
 8 And as regards timing, although Article VII(2) does  
 9 not specify precisely when such information must be  
 10 provided, the clear linkage, we say, between a party  
 11 formulating plans to construct engineering works "which  
 12 would cause [or be likely to cause] interference with  
 13 the waters", that's the first element; the second  
 14 element, the notification of this development and the  
 15 provision of relevant information; and then the third  
 16 element, that the purpose of this is to "enable the  
 17 other Party to inform itself of the nature, magnitude  
 18 and effect of the work", the clear linkage between these  
 19 three elements necessarily implies that the notification  
 20 and provision of information must be timely to enable  
 21 the specified objectives in the article to be achieved.  
 22 And I will come back to this to try and make it a little  
 23 bit more specific in just a moment.  
 24 Now, the Annexure D, paragraph 9 and Appendix II  
 25 information is more granular in terms of timing, in

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14:31 1 terms of the information that must be provided, and in  
 2 terms of the purpose of the information exchanged. It  
 3 must be provided "at least six months in advance of the  
 4 beginning of construction of river works connected with  
 5 the Plant"; the information must be the information that  
 6 is specified in Appendix II; and the information must be  
 7 provided for purposes of enabling Pakistan to evaluate  
 8 the information, and make any objection that it  
 9 considers may be warranted. So it's more specific in  
 10 all of the details, by contrast with Article VII(2).  
 11 Relevant to your questions, the very first category  
 12 of information required by Appendix II is a "General map  
 13 showing the location of the site", and related  
 14 information. And having regard to this provision,  
 15 Pakistan anticipates that, were India to have been here  
 16 for this hearing, that India's position would have been  
 17 to say that the fact that location information is only  
 18 specified to be provided at this point, at the  
 19 six months point, implies that such information need not  
 20 be provided earlier.  
 21 Unsurprisingly, Pakistan does not agree with that  
 22 putative analysis that India might advance, for three  
 23 reasons.  
 24 First, we say that that analysis would not just  
 25 circumvent but would entirely obliterate the

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14:35 1 information-sharing obligation under Article VII(2)]  
 2 crystallize and what categories of information must be  
 3 exchanged to make the notification process meaningful?"  
 4 In Pakistan's view, this specifically requires India  
 5 to supply Pakistan with information on works which would  
 6 interfere with the waters and would materially affect  
 7 Pakistan. There can be no doubt whatever that the  
 8 planning of a run-of-river HEP on the Western Rivers  
 9 falls into this category.  
 10 And it requires that that information is provided at  
 11 the point at which India arrives at the position or must  
 12 reasonably be deemed to have arrived at the position,  
 13 taking into account good faith -- so it's not just when  
 14 India says it arrives at the position, but must  
 15 reasonably be deemed to have arrived at the position --  
 16 that it "plans to construct" -- that's the language of  
 17 Article VII(2) -- "plans to construct" a run-of-river  
 18 HEP at the particular site. It is at that point that we  
 19 say that the Article VII(2) obligation kicks in.  
 20 So what does this mean in practice?  
 21 Mr Chairman, members of the Court, you will recall  
 22 that Dr Hayat and Mr Malik's presentation during the  
 23 site visit, on 24 April 2024, addressed the different  
 24 phases involved in HEP design. This was on their  
 25 slide 5. And they observed that the "HEP design usually

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14:33 1 Article VII(2) obligation. If information with that  
 2 kind of specificity only had to be provided six months  
 3 before, what then is the purpose of Article VII(2)?  
 4 It would be obliterated.  
 5 Second, we say that the structure and content of the  
 6 Appendix II enumeration of information to be provided  
 7 makes it quite clear that the requirement to provide  
 8 location information as a part of the Appendix II  
 9 information exchange is to properly locate  
 10 geographically the detailed hydrologic, hydraulic,  
 11 design and general data that must be provided, because  
 12 otherwise there would be no way of knowing to what that  
 13 other information related. So the location information  
 14 in paragraph 1 of Appendix II is essentially to say: all  
 15 the other information that you are required to provide  
 16 must be linked to a particular site.  
 17 Third, India is subject to broader  
 18 information-sharing and cooperation arrangements,  
 19 including as regard tours of inspection to enable  
 20 Pakistan to ascertain "the facts connected with ...  
 21 works or sites on the Rivers".  
 22 I'm going to join up the dots, I hope, now. So how  
 23 do we answer your question?  
 24 Question 3 asks:  
 25 "When specifically in the planning stage does [the

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14:36 1 goes through five phases before construction can  
 2 commence". So these are pre-construction phases. And  
 3 the five phases that they identified -- which we take to  
 4 be entirely uncontroversial -- are: first of all, the  
 5 "Project concept"; second, a "Pre-feasibility study";  
 6 third, a "Feasibility study"; fourth, the preparation of  
 7 an "engineering design"; and fifth, the final stage is  
 8 that of "finali[sing] the project design in conjunction  
 9 with the contractor". Those are the five stages.  
 10 Now Pakistan does not consider that India is obliged  
 11 to provide site information at the point of project  
 12 conception or at the point of pre-feasibility studies or  
 13 even at the point of feasibility studies, as at these  
 14 points we accept that India cannot reasonably be deemed  
 15 to have formed a "plan" to "construct" an engineering  
 16 work, a run-of-river HEP, on a given site.  
 17 But at the point at which India commissions  
 18 an engineering design, it is Pakistan's view that its  
 19 obligation to inform under Article VII, paragraph (2)  
 20 kicks in. By that point, the planning process has moved  
 21 beyond mere conception to the first stages of  
 22 implementation. And crucially, at that point it is not  
 23 too late for the planning to be revisited in the light  
 24 of concerns that Pakistan may express. It is at the  
 25 engineering design stage that the project owner would

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14:38 1 circulate the design to stakeholders in order to obtain  
 2 the requisite approvals, but approvals will not yet have  
 3 been given. So the process at that point is, if you  
 4 like, crossing a design watershed.  
 5 I refer also to Mr Shah's testimony on Monday in  
 6 which he said that sharing of information by India with  
 7 Pakistan "after completion of the detailed engineering  
 8 design" would give, in his words:  
 9 "... a brighter chance to converge on the designs or  
 10 on the objections raised by Pakistan, rather than giving  
 11 just six months to Pakistan and then expecting that,  
 12 'Either Pakistan will accept our stance or we will go  
 13 ahead'."  
 14 That's transcript Day 1, page 174, lines 12-24.  
 15 Pakistan considers that this interpretation, the  
 16 interpretation that I've just advanced about  
 17 Article VII, paragraph (2), is supported by the object  
 18 and purpose of the Treaty, notably by the  
 19 information-sharing obligations under Article VII(2),  
 20 and indeed that those under Annexure D are not an end in  
 21 itself: they are the means by which the Treaty seeks to  
 22 avoid conflicts between the parties. It furthers, in  
 23 other words, in the words of the preamble to the Treaty,  
 24 the goal of settling "in a cooperative spirit ... all  
 25 such questions as may hereafter arise".

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14:40 1 This sharing of information is also the means by  
 2 which the Treaty allows the parties to satisfy  
 3 themselves that the obligations of the other party are  
 4 being met. The exchange of information, and the  
 5 consideration of the views of the other party that it is  
 6 intended to facilitate, has the purpose of enabling  
 7 adjustments to be made to plans for projected works so  
 8 that both parties are satisfied that the works are  
 9 compatible with the Treaty.  
 10 Now we go beyond just the object and purpose of  
 11 the Treaty and we say that Pakistan's reading is also  
 12 supported by the principle of effectiveness that must  
 13 inform the interpretation and application of the Treaty.  
 14 The provisions of information at the stage of completion  
 15 of the detailed engineering design would give the  
 16 parties an opportunity to endeavour to reach agreement  
 17 that India's Western run-of-river HEPs will not fall  
 18 foul of Annexure D far in advance of, for example, the  
 19 appointment and mobilisation of a specific contractor;  
 20 the commencement and completion of preliminary works,  
 21 such as the construction of access roads; the  
 22 development of stockpiles, and so on. This, once again,  
 23 is addressed in Mr Shah's witness statement: that's  
 24 PER-1 at paragraph 79. And it would therefore also  
 25 facilitate good faith engagement between the parties,

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14:41 1 without influence of such factors as sunk  
 2 costs/additional costs that would accrue at the point of  
 3 design at a later stage.  
 4 Mr Chairman, members of the Court, I note also --  
 5 just for purposes of, if you like, providing belt and  
 6 braces -- I note that Pakistan's reading of these  
 7 information-sharing obligations under the Treaty also  
 8 comports with the approach adopted to such obligations  
 9 as a matter of general international law. You are  
 10 guided and bound by the Treaty, but general  
 11 international law -- particularly contemporary general  
 12 international law -- says the same thing, notably with  
 13 regard to situations concerning potential environmental  
 14 harm.  
 15 For example, the International Court of Justice, in  
 16 a judgment handed down in 2010 in the Pulp Mills case  
 17 between Argentina and Uruguay, addressed  
 18 information-sharing obligations in the context of  
 19 a treaty that addressed environmental issues in  
 20 connection with the construction of pulp mills on the  
 21 River Uruguay, and it did so in terms that are entirely  
 22 consistent with Pakistan's submission in respect of the  
 23 information-sharing obligations under the Treaty.  
 24 Now I note -- this is perhaps our oversight; maybe  
 25 we didn't think that we'd be getting to this point --

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14:43 1 but I note that the Pulp Mills judgment is not on the  
 2 record of this case. It is, of course, a publicly  
 3 available award; and significantly, it is addressed  
 4 expressly in paragraph 450 of the Kishenganga partial  
 5 award. So you have that reference.  
 6 So this brings me to the issue of the information  
 7 that is required to be exchanged.  
 8 To make the exchange of information meaningful --  
 9 this is the exchange of information under Article VII,  
 10 paragraph (2) -- Pakistan considers that, at a very  
 11 minimum, the information that must be exchanged, passed  
 12 from India to Pakistan, at the point when the plan to  
 13 construct reaches the engineering design phase, must, at  
 14 a minimum, include: first of all, the intended location  
 15 of the site of the plant -- without that, it's not  
 16 useful -- second, the detailed engineering design, in  
 17 the form of what's often described in Indian industry  
 18 parlance, "the detailed project report"; and third,  
 19 a study of alternatives of various designs of the  
 20 project on the basis of soundness and economy and other  
 21 regulatory requirements. Without that bare minimum of  
 22 information, Pakistan is not going to be in a position  
 23 to undertake the evaluation that it is entitled to make  
 24 under Article VII, paragraph (2).  
 25 So with this, I come to a number of briefer

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14:44 1 observations in response to questions 4(a) and 4(d).  
 2 Question 4(a) asks whether "the constraints that  
 3 exist in the Treaty for the design of a HEP establish  
 4 an obligation on India when it selects a site for  
 5 a HEP"; and "If so, what [are those] obligation[s]?"  
 6 Mr Chairman, members of the Court, I hope it follows  
 7 from what I've said already, and what we said in the  
 8 first round, that Pakistan does indeed consider that  
 9 India is under an obligation when it comes to site  
 10 selection. India has an overriding obligation to comply  
 11 with the Treaty, with its obligations under the Treaty.  
 12 It is required, therefore, to select a site that will  
 13 enable it to meet its Treaty commitments. The corollary  
 14 of this is that India is precluded from choosing a site  
 15 that would necessarily lead to a breach of its  
 16 obligations under the Treaty.  
 17 Further, as Professor Webb stated in her  
 18 observations, India cannot, through its choice of site,  
 19 manufacture circumstances for purposes of enabling it to  
 20 advance a necessity argument when it comes to its  
 21 compliance with its obligations under, for example,  
 22 paragraph 8(d) of Annexure D.  
 23 As to the content of the obligations with regard to  
 24 site selection, it may be simply stated as an obligation  
 25 to select a site that will enable India to comply with

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14:46 1 its Treaty obligations.  
 2 This brings me to question 4(d), on whether India  
 3 has "an obligation to provide Pakistan [with  
 4 an] opportunity to review its site selection more than  
 5 six months in advance of the beginning of construction".  
 6 And you'll recall that paragraph 9 of Annexure D has  
 7 that "six months" clock.  
 8 This point has already been addressed in my  
 9 observations under Article VII(2). But just to draw  
 10 two threads together here, the interaction between the  
 11 Article VII(2) information-sharing obligation and the  
 12 Article VIII(4)(d) tour of inspection obligation  
 13 requires India to allow Pakistan to review site  
 14 selections more than six months in advance of the  
 15 beginning of construction, as early as the point at  
 16 which India provides the information required under  
 17 Article VII(2) and then Pakistan requests a tour of  
 18 inspection under Article VIII(4)(d). So the confluence  
 19 of those two provisions: India's obligation to provide  
 20 information when its plan to construct is crystallised  
 21 at the point of engineering design; and Pakistan's right  
 22 to require a tour of inspection under  
 23 Article VIII(4)(d).  
 24 To conclude on this point, Mr Chairman, members of  
 25 the Court, I note that the issue of site selection was

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14:48 1 expressly addressed by the Kishenganga Court in its  
 2 decision on India's request for clarification or  
 3 interpretation at paragraphs 33 and 34.  
 4 Mr Chairman, members of the Court, this brings me to  
 5 your question 6, by which you asked whether India had  
 6 acted in compliance with the Kishenganga Court's partial  
 7 award and final award.  
 8 THE CHAIRMAN: Thank you, Sir Daniel. Since you're moving  
 9 on to another issue now, I thought I would just pause  
 10 and see if there are any questions by the members  
 11 regarding the information-sharing issues that you've  
 12 just discussed.  
 13 In that case, I have a couple of questions I'd like  
 14 to put to you about it.  
 15 So first of all, in terms of the meaning of the  
 16 Article VII(2) obligation, I take it that you would  
 17 agree that, on timing issues, whatever is happening has  
 18 to happen earlier than six months before construction?  
 19 SIR DANIEL: Yes.  
 20 THE CHAIRMAN: I didn't hear you say that, but it seemed to  
 21 follow from what you said, and perhaps the text gives us  
 22 a little bit of insight in that regard.  
 23 On the issue of scope of what -- well, "scope" may  
 24 be the wrong word. On the issue of at what point in the  
 25 planning process the obligation crystallises, if I heard

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14:49 1 you correctly, it's at the point where India commissions  
 2 an engineering design.  
 3 SIR DANIEL: Yes.  
 4 THE CHAIRMAN: It strikes me that at that point there is  
 5 a particular site that has been identified. So you are  
 6 not arguing that the Article VII(2) information-sharing  
 7 is necessarily triggered when more than one site is  
 8 being contemplated, before India settles on a particular  
 9 location. Is that correct?  
 10 SIR DANIEL: I suppose, Mr Chairman, we are trying to be  
 11 reasonable and sensible in our approach to this. And  
 12 I think as I mentioned on Friday, when, if I recall  
 13 correctly, you took me to these points again,  
 14 I identified that really Article VII(2) is going to work  
 15 better when there in fact is a cooperative spirit  
 16 between the parties.  
 17 As I recall, I also drew attention to the fact that  
 18 in a number of instances, Pakistan finds itself  
 19 discovering India's intent by reference to press reports  
 20 or other public information. This was the case with  
 21 regards to the Kishenganga plant, I think, initially  
 22 back in 1988.  
 23 Were the Treaty to be working well, I think our  
 24 position would be that when India is beginning to  
 25 looking at sites, it may come along to Pakistan and say,

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14:51 1 "We're looking at sites along the Kishenganga-Neelum  
 2 River or along the Jhelum or along the Chenab. This is  
 3 obviously also going to have potential implications  
 4 downstream. Let's approach this cooperatively". Now so  
 5 far, that hasn't happened, or at least it hasn't  
 6 happened since 1992.  
 7 We are also mindful that India must have a latitude  
 8 to explore and consider and rule out for itself, so it  
 9 may not be appropriate for Pakistan to be brought in  
 10 right, for example, at the pre-feasibility point. And  
 11 we are driven, I have to say, by the text of what  
 12 Article VII(2) says. It says:  
 13 "If either Party plans to construct any engineering  
 14 work ..."  
 15 And as we have considered it, in the light of the  
 16 five stages before one gets to construction, it seemed  
 17 to us that "plan[ning] to construct" crystallises at the  
 18 point where India has moved beyond feasibility, where  
 19 it may, of its own motion, simply have ruled out various  
 20 sites, to the point of engineering design.  
 21 Now I'm perfectly willing to accept -- and indeed,  
 22 I think this was the tenor of my submissions on  
 23 Friday -- that it may very well be that at the  
 24 feasibility stage, or even perhaps at the  
 25 pre-feasibility stage, if, if you like, within India's

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14:54 1 a study of alternatives of various designs of the  
 2 project on the basis of soundness and economy and other  
 3 regulatory requirements.  
 4 So I think our expectation is that when it comes to  
 5 the Article VII information and India must be deemed to  
 6 have crystallised its plans to construct, it must have  
 7 done so on the basis that it has actually considered  
 8 other alternatives. And that would then be the point at  
 9 which it would come to Pakistan and say, "Look, we've  
 10 considered this alternative upstream, we've considered  
 11 that alternative downstream. We know that the  
 12 alternative downstream, because of the topography, may  
 13 allow desanders to be easily constructed. But in fact,  
 14 what we are proposing to do is to construct upstream,  
 15 to sink a little bit more cost into it and to put the  
 16 desanders underground". Now that may be the kind of  
 17 discussion that's going to be more useful to be had  
 18 between India and Pakistan, because India's thinking  
 19 will have moved beyond just, "Oh, we've got an idea to  
 20 put a site in this particular location".  
 21 But as I say, this really does depend on good faith  
 22 on India's part. And it may be that planning to  
 23 construct actually does go back at an earlier point, to  
 24 feasibility or pre-feasibility, because there may be  
 25 a policy directive -- I mean, who knows? -- there may be

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14:53 1 planning this becomes a done deal, then that's the point  
 2 at which India needs to consult.  
 3 So it's when the party plans to construct.  
 4 THE CHAIRMAN: I suppose the reason why I asked the question  
 5 was: in the midst of last week's submissions, there was,  
 6 on more than one occasion, the proposition put forward  
 7 that: at a particular site, India might say, "Well,  
 8 because of this particular location, we need to do  
 9 a low-level outlet", to which I thought I saw Pakistan  
 10 representing to us, "Well, what if there's a site  
 11 upriver that could be used, a smaller dam and no need  
 12 for the outlet?"  
 13 If that's the kind of conversation that needs to  
 14 happen, can that happen in the context of what you've  
 15 just presented to us? It may be it can. Maybe I'm  
 16 conceiving of the "site" as being a bit too narrow, and  
 17 that actually it can be a stretch of the river where  
 18 there's possibilities to happen.  
 19 SIR DANIEL: No, I think, Mr Chairman, the answer to your  
 20 question actually perhaps lies in what we've identified  
 21 as the information that must be provided at that point.  
 22 Because you'll recall that I identified three categories  
 23 of information: one was the intended location of the  
 24 site; second was the detailed engineering design, in the  
 25 form of the detailed project report; and the third was

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14:55 1 a policy directive that in a particular region, there is  
 2 a political decision that a site will go there  
 3 regardless. At that point, India needs to come to us.  
 4 THE CHAIRMAN: So last question: I thought I heard you say  
 5 that basically the point in time when the information is  
 6 required under the Article VII(2) approach is when India  
 7 commissions an engineering design.  
 8 SIR DANIEL: Yes.  
 9 THE CHAIRMAN: But then I thought I heard you say that the  
 10 information to be exchanged at that point is a detailed  
 11 engineering design, also known as a "detailed project  
 12 report".  
 13 So I was a little bit confused. Are you saying the  
 14 engineering design has been commissioned and produced,  
 15 that's the point in time, as opposed to when you are  
 16 about to develop the design?  
 17 SIR DANIEL: I think probably, Mr Chairman, I was being  
 18 insufficiently precise there. And maybe it's just  
 19 a question of how the Indian engineering and design  
 20 process will be undertaken.  
 21 It can't, self-evidently, be at the point at which  
 22 the engineering design is complete, done and dusted,  
 23 blessed, and the next stage is construction works,  
 24 because that would effectively take it into the  
 25 paragraph 9 decision. It may be that it's a little bit

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14:57 1 too early to do it at the point at which a Ministry of  
 2 Water Resources official says, "Well, we must now  
 3 commission an engineering design".  
 4 And I think the language then comes back to  
 5 Article VII(2), which says India:  
 6 "... shall supply such data relating to the work as  
 7 may be available and as would enable the other Party to  
 8 inform itself of the nature, magnitude and effect of the  
 9 work."  
 10 And it may be -- and indeed it should be -- that  
 11 this provision of information requirement is not simply  
 12 a one-shot exercise: India provides all the information  
 13 as it has available, and then next week it has more  
 14 information, but it says, "Well, we've already provided  
 15 you with information".  
 16 So it's going to be at some reasonable point,  
 17 I think, along that engineering design continuum. It  
 18 may not be the very first moment, it certainly won't be  
 19 the very last moment, but it's going to be somewhere  
 20 where that information becomes available and useful to  
 21 the other party.  
 22 THE CHAIRMAN: Well, that's fine. I'm just bearing in mind  
 23 your hope that we'll be relatively granular in our  
 24 guidance.  
 25 SIR DANIEL: Yes.

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14:58 1 THE CHAIRMAN: And it seems to me that it might be useful to  
 2 know if you have a particular view on where in the  
 3 continuum that might reside. You don't need to answer  
 4 it now; tomorrow would be fine. Or you just leave it as  
 5 it is, and leave it to the Court to consider.  
 6 SIR DANIEL: We will think about that further. We are happy  
 7 in principle, of course, to leave it to the Court. But  
 8 if there's further guidance that we can give on that,  
 9 we'll come back and do that tomorrow. So that's very  
 10 helpful. Thank you, Mr Chairman.  
 11 THE CHAIRMAN: That's fine. Please proceed whenever you're  
 12 ready.  
 13 SIR DANIEL: Thank you, Mr Chairman. I note that  
 14 I immediately have been in breach of my own time limits,  
 15 as we're almost approaching the hour and I've got  
 16 a little way to go. But as I say, we've got time, and  
 17 I don't feel overly stressed about that aspect.  
 18 So this brings me to your question 6, by which you  
 19 ask whether India has "acted in compliance with the  
 20 Kishenganga Court's Partial and Final Awards as they  
 21 relate to the KHEP". And you will find elements of this  
 22 addressed in Mr Shah's testimony at transcript Day 1,  
 23 page 185, lines 2-19. But let me give you a rather  
 24 fuller response, because we do have a fuller response to  
 25 give you, including through the exhibits and

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1 demonstratives that you now have.  
 2 Just by way of framing this, the KHEP was reportedly  
 3 commissioned on 19 August 2018, when Indian Prime  
 4 Minister Narendra Modi inaugurated the project.  
 5 There are two key issues concerning India's  
 6 compliance with the Kishenganga Court's awards and  
 7 decisions that we need to consider. The first is  
 8 India's compliance with the Court's prohibition on  
 9 drawdown flushing, which is addressed in its partial  
 10 award -- I think it's Decision paragraphs B in the  
 11 Partial Award -- and also in its Decision on  
 12 Clarification. The second is India's compliance with  
 13 the minimum flow/environmental flow requirements, which  
 14 are addressed in the Court's Final Award in Decision  
 15 paragraphs A.  
 16 Let me deal with the issue of drawdown flushing  
 17 first, because I can deal with that more quickly. The  
 18 only thing I can say at this point is the following.  
 19 From Pakistan's downstream monitoring, Pakistan has  
 20 not detected that India has so far undertaken any  
 21 drawdown flushing, any empty flushing of the KHEP.  
 22 Whether India wishes to keep open this possibility is  
 23 not clear. But what is evident is that India is  
 24 undertaking drawdown flushing of its Western River HEPs,  
 25 in contravention of the Kishenganga partial award. And

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15:01 1 the clearest example of this is India's recent flushing  
 2 of Salal, to which Mr Shah referred in his evidence,  
 3 which was plainly in breach of the 1978 agreement, that  
 4 agreement having been concluded under the framework of  
 5 the Treaty.  
 6 It is also clear that India's design of the KHEP,  
 7 with orifice spillways below the dead storage level,  
 8 would enable India to undertake drawdown flushing,  
 9 should it choose to do so. So the sword of Damocles is  
 10 hanging over Pakistan's head.  
 11 So I then turn to the issue of the minimum flow  
 12 ordered by the Kishenganga Court in its final award.  
 13 This is at Decision paragraphs A(1) and (2) of that  
 14 final award. And by those decisions, India is required  
 15 to release a minimum of 9 cumecs flow downstream of the  
 16 dam -- so that's downstream, 9 cumecs -- given the need  
 17 to balance power generation with environmental and other  
 18 downstream uses. And that is when the inflow of the dam  
 19 site meets or exceeds this magnitude. If the inflow at  
 20 the dam site is less than 9 cumecs, India is required to  
 21 release 100% of the inflow downstream of the dam.  
 22 Now if we may have the screen, please. Could we  
 23 turn the screen on, please, for exhibits? Thank you.  
 24 Megan, perhaps you could just focus on the top  
 25 flowchart, if you could enlarge -- are you able to

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15:03 1 enlarge it, so you focus on the top half of that page?  
 2 You now have a number of new exhibits that go to  
 3 this issue, and notably Exhibits P-642 to P-644. There  
 4 are also other documents that were already in the record  
 5 addressing this issue. The relevant exhibit, P-644, is  
 6 on the screen now, and there is a demonstrative which  
 7 I believe you have: something that looks like that  
 8 (indicating), a three-page demonstrative. Has that been  
 9 handed out? I believe it's at tab 17. Yes, okay. So  
 10 the demonstrative speaks to the exhibit that's on the  
 11 screen, and let me take you through the demonstrative.  
 12 Pakistan is not in a position to gauge the flow of  
 13 the Kishenganga-Neelum River at any point on India's  
 14 side of the Line of Control, either upstream or  
 15 downstream. So what Pakistan is able to monitor is  
 16 limited. The only information available to Pakistan  
 17 remains that provided by India either under Article VI,  
 18 paragraph (1), to which I drew your attention earlier,  
 19 which is the information-sharing in relation to the  
 20 hydrology of the river and the use of the waters; and to  
 21 monitor the inflows that enter Pakistan crossing the  
 22 Line of Control. WAPDA -- which is Pakistan's Water and  
 23 Power Development Authority -- has a surface-water  
 24 hydrology project which you'll see referred to in the  
 25 demonstrative, which has located two observation

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15:05 1 stations: one along the Neelum River, which is just  
 2 a little bit further downstream when the Neelum is  
 3 flowing fully in Pakistan; and one just above that,  
 4 along a tributary that flows into the Neelum River, to  
 5 allow Pakistan to undertake a calculation of what waters  
 6 of the Neelum River are in fact flowing from the  
 7 Kishenganga plant into Pakistan.  
 8 You'll see the detail set out on the demonstrative,  
 9 and I won't go through all of it closely. But by  
 10 undertaking a calculation based on these two gauging  
 11 stations, Pakistan is able to calculate the flows of the  
 12 Neelum River into Pakistan at the Line of Control.  
 13 These are automatic gauging stations that have been  
 14 operational since 1 November 2018, so that's very  
 15 shortly after the Kishenganga plant became operational.  
 16 The gauging is specifically for the purpose of  
 17 monitoring whether or not the quantum of flow into the  
 18 river, immediately after it crosses the Line of Control  
 19 from the Indian side, is in accordance with the  
 20 Kishenganga final award; that's Decision A(1). The  
 21 frequency of the data that Pakistan collects is hourly  
 22 data. And since 1 November 2018 until 9 July 2024 --  
 23 that's just a few days ago -- WAPDA has collected  
 24 49,872 readings from these gauging stations.  
 25 On the basis of these data, Pakistan has identified

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15:06 1 that the downstream flow from the KHEP across the  
 2 Line of Control was less than 9 cumecs during the period  
 3 from October 2021 to March 2022; in August 2022; in  
 4 September to October 2023; and in January 2024. And  
 5 this is what is shown by the table and the figures in  
 6 front of you: the number of hourly instances and  
 7 corresponding number of days is given in the table; and  
 8 the flow is shown in the figure.  
 9 Now, there is some additional information which  
 10 India has provided, which you'll see on the  
 11 demonstrative but again I won't go through in detail,  
 12 which is river flow information which is supplied by  
 13 India from its own gauging stations. And on the basis  
 14 of India's data, Pakistan has been able to determine  
 15 that the inflow into the Kishenganga plant was only less  
 16 than 9 cumecs on five occasions over the course of the  
 17 period 1 January 2020 to 31 August 2023, which is the  
 18 last date on which India provided information.  
 19 Taking these together, it shows that in fact there  
 20 have been a considerable number of occasions in which  
 21 the flow of the water from the Kishenganga plant has not  
 22 complied with the Kishenganga final award.  
 23 The PCIW has raised these issues formally with his  
 24 Indian counterpart in correspondence -- you'll see that  
 25 indicated on the demonstrative -- first of all, dated

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15:08 1 17 June 2022, at Exhibit P-217, and 8 September 2022,  
 2 P-219; to which the Indian Commissioner responded on  
 3 7 October, P-642, in which he asked for the data of the  
 4 Karimabad and Taobut for the period 2018 to 2022.  
 5 Although the PCIW provided the data in correspondence  
 6 dated 18 November 2022, at P-643, and the PCIW urged his  
 7 Indian counterpart to arrange a site visit -- that's  
 8 under Article VIII, paragraph (4)(d) -- no further  
 9 response was received from India.  
 10 So our position is that India has historically, at  
 11 various points, been in breach of the minimum flow  
 12 obligations derived from the Kishenganga award.  
 13 I note also, as a separate but related matter, that  
 14 the PCIW, in recent years, has emphasised to his Indian  
 15 counterpart on numerous occasions the importance of  
 16 an inspection by Pakistan of the arrangements made by  
 17 India at the Kishenganga dam to enable Pakistan to  
 18 verify the release of minimum environmental flows in  
 19 accordance with the Kishenganga final award. And I will  
 20 simply identify for you -- but they're all on the  
 21 demonstrative -- various of the exhibits: that's  
 22 Exhibits P-188, P-202, P-203, P-208, P-209, P-210,  
 23 P-211, P-212, P-213 and P-214. And as you will recall,  
 24 I'm sure, very clearly from the competence phase, India  
 25 not only refused to allow a tour of inspection over all

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15:10 1 of these ten years or more, but indeed India invariably  
 2 did not even bother to reply to the PCIW correspondence.  
 3 With that, Mr Chairman, members of the Court, I turn  
 4 to the issue of weaponisation, which I'm going to be  
 5 able to address very briefly, and I hope I won't detain  
 6 you too much longer.  
 7 So this brings me to question 13, which you  
 8 described as the issue of weaponisation. And by this,  
 9 you noted that "Pakistan has expressed a concern  
 10 regarding the potential weaponization of HEPs on the  
 11 Western Rivers through increased controllable storage";  
 12 that Pakistan "has also expressed the view that India is  
 13 simply using 'off the shelf' design principles, not  
 14 tailored to the design restrictions of the Indus Waters  
 15 Treaty". And having regard to this, you asked what  
 16 Pakistan "understand[s] to be India's motivation for the  
 17 HEP designs [that] it has proposed for sites on the  
 18 Western Rivers", and "What evidence supports Pakistan's  
 19 understanding of India's motivations".  
 20 Just to come back, for the sake of a clean  
 21 transcript for you, you will find elements of responses  
 22 to these questions at the following long list of  
 23 transcripts, so I'll just go through them quickly:  
 24 there's Day 1, page 44, line 21 to page 46, line 18;  
 25 Day 1, page 87, line 20 to page 88, line 5; Day 1,

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15:14 1 THE CHAIRMAN: I highly doubt that, Sir Daniel! (Pause)  
 2 SIR DANIEL: So as I have addressed previously, India is  
 3 designing for the more than 5,000 large dams that it has  
 4 countrywide, not for the 201 that it has constructed or  
 5 has planned for the Western Rivers. And it is apparent  
 6 to Pakistan that the Treaty constraints on India's  
 7 Western Rivers projects are an irritant to India that  
 8 India would prefer to circumvent, to avoid, or simply to  
 9 disregard.  
 10 And as I observed as a general matter, and as  
 11 Professor Webb has addressed in the particular, India  
 12 has now for decades been presenting Pakistan with one  
 13 largely standard design for its HEPs, and this  
 14 off-the-shelf approach has been the subject of  
 15 discussion in PIC meetings.  
 16 And I pause here just to note that it is quite  
 17 significant, we consider, that India has run-of-river  
 18 HEPs on the Eastern Rivers, and the design is exactly  
 19 the same as the run-of-river HEPs on the Western Rivers.  
 20 So it appears to us that when India comes to design for  
 21 the Western Rivers, it's not making any adjustments for  
 22 Treaty purposes, to adjust its Eastern Rivers HEP design  
 23 to cater for the Treaty constraints under the  
 24 Western Rivers.  
 25 Two examples will suffice of where this

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1 page 217, line 12 to page 220, line 18; Day 4, page 4,  
 2 line 19 to page 5, line 4; Day 4, page 221, lines 8-11;  
 3 Day 5, page 221, lines 7-17.  
 4 But I note as well on Day 4 that Professor Webb's  
 5 submissions addressed at some length the "typical Indian  
 6 HEP design", and this was in conjunction with the images  
 7 provided on her slides at slides 19, 42, 62 and 63, and  
 8 this is PHM-12.  
 9 As this recitation of transcript references  
 10 indicates, we have already addressed this question in  
 11 some detail in our first-round submissions, and I am  
 12 therefore going to confine myself only to one or two  
 13 brief points of observation.  
 14 As I have addressed, India is designing for the more  
 15 than 5,000 large dams that it has in the country, not  
 16 for the 201 that it has constructed or has planned for  
 17 the Western Rivers. It is apparent to Pakistan that the  
 18 Treaty constraints on India's Western Rivers  
 19 projects ...  
 20 THE CHAIRMAN: Just a moment Sir Daniel. I think we should  
 21 go ahead and close the windows, unfortunately.  
 22 SIR DANIEL: I note that previously there was applause,  
 23 which was attributed to appreciation of Professor Webb's  
 24 submissions. I presume that the noise coming from  
 25 outside is not horror at my submissions!

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15:15 1 off-the-shelf approach has been the subject of  
 2 discussion in PIC meetings.  
 3 The first is the example that I took you to last  
 4 week, of the 90th meeting of the PIC, which was convened  
 5 especially to discuss Baglihar. If memory serves me, it  
 6 was in 2004. This was Exhibit P-544 at paragraphs 6.1.3  
 7 and 6.2.3, in which the Indian Commissioner stated in  
 8 terms that its Baglihar plant design was a standard  
 9 Indian design, it was "not an exception". And  
 10 Pakistan's Commissioner then responded noting that the  
 11 Treaty had placed restrictions on the design and  
 12 operation of run-of-river plants on the Western Rivers,  
 13 and that a standard design that did not take into  
 14 account India's treaty obligations was not acceptable or  
 15 not appropriate.  
 16 The second example is the 111th PIC meeting, and  
 17 that's at Exhibit P-25 at paragraph 29, which  
 18 Professor Webb also referred to in her slides -- that's  
 19 PHM-12 at slide 20 -- in which the Pakistan Commissioner  
 20 for Indus Waters observed that:  
 21 "... despite the fact that clear guidelines are  
 22 provided regarding sediment management in Baglihar and  
 23 Kishenganga ... yet India keeps on proposing deep  
 24 orifice spillways in its designs."  
 25 Mr Chairman, members of the Court, this addresses

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15:17 1 both motivation and evidence, the two parts of your  
 2 question: a simple disinclination on India's part to  
 3 observe its Treaty obligations when it comes to  
 4 Pakistan. It is too bothersome and too burdensome to  
 5 India, and India prefers simply to build, build, build  
 6 on the Western Rivers.  
 7 But beyond this is also what Pakistan perceives to  
 8 be India's policy imperative of wishing to appropriate  
 9 more and more of the waters of the Indus Basin. This is  
 10 evident from India's approach to the stopping of the  
 11 flow of the Eastern Rivers and its approach towards  
 12 maximising the storage of the run-of-river HEPs on the  
 13 Western Rivers, in the face of efficient and effective  
 14 design possibilities that would enable India to observe  
 15 its Treaty commitments.  
 16 India is doing what many -- not all, but what many  
 17 upper riparians do or want to do: namely, to expropriate  
 18 the water as it passes through the territory under their  
 19 control. But the very purpose of the Indus Waters  
 20 Treaty was to avoid this by dividing the watersheds.  
 21 Mr Chairman, members of the Court, I come to my  
 22 final very brief observations, which is simply to  
 23 address the point, Mr Chairman, that you raised on  
 24 whether it would be useful and appropriate for the Court  
 25 to give a preliminary partial award on the

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15:19 1 the parties could be notified to this effect, including  
 2 on the likely timing of such a preliminary partial  
 3 award, as this would almost certainly be very relevant  
 4 to the parallel Neutral Expert proceedings, elements of  
 5 the timing of which are in the public domain and on the  
 6 record of these proceedings.  
 7 And if you do decide to proceed in this manner, you  
 8 may also wish to consider whether it would be necessary  
 9 or appropriate to your analysis and conclusions on the  
 10 question 35(a) issues for you also to unpack and  
 11 elaborate on the general duty of mutual respect and  
 12 comity which you addressed in PO6, apart from its  
 13 implications for the organisation of the respective  
 14 proceedings. This is an immensely important principle  
 15 and one that would no doubt benefit from further  
 16 elaboration, including for the benefit of the  
 17 Neutral Expert.  
 18 Mr Chairman, members of the Court, that concludes my  
 19 opening submissions for today. I will be back tomorrow  
 20 to close Pakistan's case. In the course of that  
 21 closing, I will address a number of the other  
 22 questions -- questions 7(a) and (b), question 8 and the  
 23 first part of question 9 -- and I will also address,  
 24 Mr Chairman, your five-step scheme on the sequence for  
 25 applying sources of law or practice.

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15:18 1 question 35(a) issues.  
 2 Pakistan agrees that a preliminary partial award on  
 3 such issues would be helpful, and that these issues  
 4 could be readily bifurcated from the remaining questions  
 5 of which the Court is seised.  
 6 This said, I note that there may be a fine line to  
 7 be drawn between the issues that might usefully be  
 8 addressed in such a preliminary award and deciding at  
 9 a preliminary stage substantive questions that may be  
 10 caught up with other matters.  
 11 There may equally be considerations of whether, in  
 12 the event that question 35(a) were to be bifurcated and  
 13 to be the subject of a preliminary award, such an award  
 14 may warrant a revisiting of questions that have already  
 15 been addressed in the hearing; and I raised these with  
 16 you, I think, when you put the point to me last week.  
 17 But both of these are speculative points, against  
 18 which Pakistan considers the Court would itself be well  
 19 placed to guard. It is simply to say that before  
 20 handing down such a preliminary partial award, the Court  
 21 would have to reflect with care about the possible  
 22 implications of such an award for that part of the case  
 23 which still remained to be addressed.  
 24 Mr Chairman, members of the Court, if the Court does  
 25 resolve to proceed in this way, it would be helpful if

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15:21 1 I note that we are not quite at the mid-afternoon  
 2 break, but getting there. Mr Chairman, with your  
 3 indulgence, it may be a good opportunity to take a break  
 4 now, so that Mr Rae, when he comes to the microphone,  
 5 will have a clear run, rather than being interrupted  
 6 ten minutes after he starts.  
 7 THE CHAIRMAN: We may make our way all the way to the break  
 8 time with questions for you, Sir Daniel! Let me turn to  
 9 my colleagues to see if there are any questions from  
 10 them. If not, I have a couple for you.  
 11 SIR DANIEL: Just to take us up to the break.  
 12 THE CHAIRMAN: Could you indicate where, in the  
 13 presentations to come, the questions relating to the  
 14 relevance of Annexure E will be addressed?  
 15 SIR DANIEL: Yes, I'm going to be addressing those in  
 16 closing tomorrow.  
 17 THE CHAIRMAN: I raise that because I do think there is some  
 18 connection with the weaponisation issue, and I don't  
 19 know if it's helpful for you to hear a little bit about  
 20 that now as you prepare for tomorrow?  
 21 SIR DANIEL: You mean hear from you some of the concerns  
 22 that are in the minds of the Court about that?  
 23 THE CHAIRMAN: Yes.  
 24 SIR DANIEL: I'd be very happy to do so. If it's possible  
 25 to do so -- and that may simply be a question of

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15:22 1 bandwidth -- it may be that we will be able to address  
 2 the Annexure E questions tomorrow morning, rather than  
 3 just in my closing.  
 4 I should note that Dr Morris, in his presentation,  
 5 either later today or perhaps now more likely tomorrow  
 6 morning, will also be addressing the questions of  
 7 weaponisation that you've asked from an engineering  
 8 perspective.  
 9 So, Mr Chairman, I'd be obviously very happy to take  
 10 your questions now; you could also save them until  
 11 you've heard Dr Morris. That depends on you, whichever  
 12 you think is going to be most efficient.  
 13 THE CHAIRMAN: I think perhaps it's best to hold them until  
 14 we hear Dr Morris. And perhaps some back-and-forth with  
 15 him -- hopefully it happens today -- might give you some  
 16 further thoughts for tomorrow.  
 17 SIR DANIEL: Thank you.  
 18 Mr Chairman, just as you speak, two points come to  
 19 mind. First of all, I expect that it's now very  
 20 unlikely that Dr Morris will get on today. But there's  
 21 also a possibility which no doubt you can reserve to  
 22 yourself, and that is that if you wish, after the close  
 23 of the hearing today, you may wish to send us some  
 24 further written questions, if you want to crystallise  
 25 those points a little bit more closely.

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15:25 1 on in the Neutral Expert proceedings or to anticipate  
 2 how the Neutral Expert might deal with those issues,  
 3 it seems to us that that is a very important principle  
 4 that would merit unpacking in any event. And insofar as  
 5 the Court has itself tied that general duty to the  
 6 conduct both of this Court and of the Neutral Expert,  
 7 it may be that you consider that further guidance on  
 8 that would be helpful.  
 9 THE CHAIRMAN: Are you in a position to indicate to the  
 10 Court Pakistan's position as to why the Neutral Expert  
 11 may not be competent in all or in some respects?  
 12 SIR DANIEL: I am not in a position to address in any way  
 13 either the detail of our paragraph 7 challenge or the  
 14 detail of India's argument. And I think we have been  
 15 not just going up to the line but have been very clear  
 16 that we stayed on one side of the confidentiality line  
 17 when it comes to those issues.  
 18 But what I can say is that it is absolutely clear  
 19 and beyond doubt that the Neutral Expert competence is  
 20 defined by two paragraphs in the Treaty.  
 21 One is paragraph 11 of Annexure D, which says that  
 22 in the event of a -- I'm not quoting it, just  
 23 paraphrasing -- but in the event of a dispute over the  
 24 information that's provided in respect of a particular  
 25 plant, that matter may be referred to one or other of

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15:23 1 THE CHAIRMAN: So let me turn now to the issue of the  
 2 preliminary partial award. You said that it might be  
 3 helpful, and that it may be relevant to the Neutral  
 4 Expert proceeding. Can you be a little more specific as  
 5 to why it would be helpful in that context?  
 6 SIR DANIEL: Mr Chairman, I suppose that I can do from  
 7 the public record of the Neutral Expert proceedings  
 8 that's on the record of this case and posted on the PCA  
 9 website.  
 10 You will know, and as I addressed in opening, the  
 11 Neutral Expert is, if I can put it this way, in the  
 12 middle of a competence process. Both Pakistan and India  
 13 have filed submissions on competence; that's paragraph 7  
 14 of Annexure F. He has convened -- again, on the public  
 15 record -- a third meeting of the Neutral Expert on  
 16 10 and 11 September to take place in front of him, in  
 17 which oral arguments are going to be made on that  
 18 matter, and then he will obviously deliver his views on  
 19 that.  
 20 We note, as I've said now and as I said last week,  
 21 that the principle that you addressed in PO6 of the  
 22 general duty of mutual respect and comity is a principle  
 23 that you tied both to your conduct of the proceedings  
 24 and the Neutral Expert's conduct of the proceedings.  
 25 And while I don't presume to address what has been going

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15:26 1 the dispute settlement mechanisms under Article IX.  
 2 And then we have paragraph 1(11) of Annexure F,  
 3 which says "Questions" -- so this is the Neutral  
 4 Expert's competence -- "Questions arising under the  
 5 provisions of", inter alia, "Paragraph 11 ... of  
 6 Annexure D".  
 7 So the task that the Neutral Expert will be faced  
 8 with -- and this you can simply surmise from the fact  
 9 that Pakistan has brought a competence challenge -- the  
 10 task that the Neutral Expert will be faced with is  
 11 determining what comes within the scope of paragraph 11  
 12 of Annexure D and paragraph 1(11) of Annexure F.  
 13 Now, you will also have seen from the publicly  
 14 available documents from the Neutral Expert proceeding,  
 15 notably the supplemental rules and the work schedule  
 16 which has been published, that the Neutral Expert has  
 17 organised his proceedings in a particular way, with  
 18 a cadence of certain specified dates and a cadence of  
 19 identified steps without specified dates.  
 20 I think that's probably all that I can say, to stay  
 21 safely on the line of confidentiality.  
 22 THE CHAIRMAN: I certainly don't want you to stray across  
 23 that line.  
 24 The reason I asked the question was: I am trying to  
 25 assess why it's helpful in the context of the Neutral

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15:28 1 Expert's work in the near term. And it seems to me that  
 2 if there was in, say, the Baglihar determination or in  
 3 the Kishenganga partial or final awards some kind of  
 4 discussion of the competence of a Neutral Expert, that  
 5 one might then wonder: is there res judicata or  
 6 precedential effects that flow from that? Then I can  
 7 begin to see the value in having a partial award from us  
 8 on this issue of res judicata effects. But given that  
 9 my own reading of those decisions is that they generally  
 10 don't address the issue of competence of the Neutral  
 11 Expert, it wasn't immediately apparent to me why  
 12 it would be helpful.

13 Now, that's different from your point about  
 14 addressing perhaps a general duty of respect and comity  
 15 between the Neutral Expert and the Court of Arbitration.  
 16 So I'm parking that momentarily and just asking more  
 17 about the other issue.

18 SIR DANIEL: Mr Chairman, let me perhaps sort of react to it  
 19 this way; but in doing so, let me say quite clearly and  
 20 for the record that in the observations that I've just  
 21 made, this is Pakistan reacting to a question that was  
 22 raised by the Court. We did not put in our final  
 23 submissions or in our oral statement a request to the  
 24 Court to make a preliminary partial award. So we were  
 25 responding there.

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15:31 1 He also relied on load. And as I said to you on  
 2 Friday -- and it's a point that we'll come back to again  
 3 and again if we need to -- the pondage calculation is  
 4 calibrated on the hydrology of the river. You cannot  
 5 have a pondage calculation under Annexure D that is  
 6 rooted in installed capacity or that is rooted in  
 7 India's statement of load, because it would just make  
 8 the entire exercise unreal and unbearable.

9 Now without for a moment saying anything about the  
 10 content of the Neutral Expert proceedings, if you had  
 11 issued a preliminary partial award on the effect of  
 12 Baglihar, the effect of the Neutral Expert  
 13 [Determination] on your proceedings, that would have  
 14 changed the nature of our case. And I think you can  
 15 draw conclusions from that.

16 THE CHAIRMAN: So a last question on this and then we can  
 17 take our break.

18 Assuming it is helpful in the context of the Neutral  
 19 Expert proceedings and other matters as we move forward,  
 20 and further taking for granted the Court will take the  
 21 time it needs to issue a well-reasoned award, is there  
 22 a particular point in time where it would be helpful, no  
 23 later than this point, to have such an award?

24 SIR DANIEL: Mr Chairman, I don't think that I can say that,  
 25 partly because we don't know how the Neutral Expert is

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15:30 1 But let me address your question in the following  
 2 way. Let's assume for the moment that this Court had  
 3 issued a preliminary partial award on the Article 35(a)  
 4 question six months ago. The nature of our pleadings  
 5 would have been very different; or, if not very  
 6 different in terms of some of the substance of the  
 7 interpretation of paragraph 8, will have been very  
 8 different in terms of the reliance that we might have  
 9 been able to place on the Kishenganga award or how  
 10 we approached the Baglihar decision.

11 We have made it absolutely plain to you -- we are  
 12 not sort of hiding the parcel here in any shape or  
 13 form -- that we consider that Raymond Lafitte's analysis  
 14 in the Baglihar determination was fundamentally flawed,  
 15 to its absolute core. There may be some residual  
 16 elements in relation to freeboard, as you heard from  
 17 Dr Miles, where we think that he got the bottom line  
 18 correct, but that's only because that wasn't sort of  
 19 inveigled by his methodology.

20 But we think he got it absolutely wrong, and the  
 21 consequence of him getting it absolutely wrong is that  
 22 you've got run-of-river plants that, on his approach to  
 23 the calculation of pondage, would have more pondage than  
 24 storage plants. Now, that just cannot be right within  
 25 the scheme of the Treaty.

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15:33 1 going to address competence, partly because we don't  
 2 know how you are going to come out. I mean, you may  
 3 come out in your award completely against us, which may  
 4 cause us all to rethink. We don't have any sense on the  
 5 public record of the timing of the subsequent phases in  
 6 the Neutral Expert's work programme: they're all written  
 7 into the public document as "TBD".

8 We are resolved here, in coming to you -- and I said  
 9 this openly on the very first day -- that you should  
 10 take as much time as you need, because the award that  
 11 you will give is an award of systemic interpretation  
 12 which goes beyond Baglihar, it goes beyond Ratle.  
 13 It goes to the 201 -- or all the other plants that may  
 14 be planned for the Western Rivers in due course, so  
 15 we want you to get it right.

16 We are conscious that, with the World Bank's pause,  
 17 Pakistan has been very, very seriously debilitated and  
 18 damaged by the long delay, because Kishenganga is now  
 19 set in stone. And whatever happens with regard to  
 20 Kishenganga, as I suggested, it's going to be a brave  
 21 Court or a brave Neutral Expert that's going to say to  
 22 India, "Tear down this dam". But you need to get it  
 23 right, and we are not going to press you beyond that.

24 Embedded in the concluding comments that I made  
 25 about this, I think that there are significant questions

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15:34 1 that the Court would need to consider and resolve for  
 2 itself if you decided that you were going to issue  
 3 a preliminary partial award. Because, for example --  
 4 and I just take a hypothetical -- if you were to say,  
 5 "We consider that we are bound by the Kishenganga Court  
 6 partial award and final award; for example, the partial  
 7 award on drawdown flushing", does that mean that you are  
 8 not going to address drawdown flushing when it comes to  
 9 the issues with which you are engaged?  
 10 So you will have to consider whether a preliminary  
 11 partial award effectively, even if not in terms,  
 12 addresses aspects of the substantive matters of which  
 13 you are seised before you actually get to them. You  
 14 will have to consider whether anything that you say  
 15 would warrant a reopening of any arguments, that we can  
 16 make submissions on what you've said.  
 17 So I don't, by any means, come to you and say: this  
 18 is absolutely straightforward, there's no controversy,  
 19 we are asking you for it. We are saying to you that: we  
 20 agree that a preliminary partial award on such issues  
 21 would be helpful; this said, I note that there may be  
 22 a fine line to be drawn, and that's a matter for you to  
 23 address in your deliberations.  
 24 THE CHAIRMAN: Very good. That's very helpful, Sir Daniel,  
 25 and much appreciated.

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16:01 1 Dr Miles will appear before you tomorrow to provide  
 2 further responses where issues of Treaty interpretations  
 3 may arise.  
 4 We have been presented with 13 main questions  
 5 concerning pondage. Several of these have secondary  
 6 elements of enquiry within the overall question. My  
 7 response will reorganise the order of the questions  
 8 somewhat to provide a progression of information, where  
 9 the response to some items may inform my subsequent  
 10 responses. Importantly, I'm only discussing primarily  
 11 six items, which are mainly technical, and Dr Miles will  
 12 pick up the remainder.  
 13 For my presentation today, I am responding to your  
 14 questions based on how the criteria presented in the  
 15 Treaty for the calculation of the maximum pondage would  
 16 be interpreted by an experienced and practising  
 17 hydropower engineer.  
 18 (Slide 2) So I'm going to start with question 26,  
 19 which, as it says here -- which I can't read with my  
 20 glasses, so I take it that you know -- there are four  
 21 elements to the question, four specific items, as  
 22 enumerated on the slide. But to understand these  
 23 issues, I want to first illustrate the meaning of the  
 24 terms and their use within the Treaty, and then we'll  
 25 come back to the specific responses.

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15:36 1 So we are indeed not only at but past the normal  
 2 time for the coffee break. I think the Court is  
 3 prepared to come back at 4 o'clock, if that's sufficient  
 4 time for you to regroup and be ready to continue.  
 5 SIR DANIEL: I think if one person can "group", then I think  
 6 Peter Rae is "grouped"; he doesn't have to regroup. So  
 7 25 minutes for a coffee break would be fine.  
 8 THE CHAIRMAN: Very good. I'll see you at 4 o'clock. Thank  
 9 you so much.  
 10 SIR DANIEL: Thank you.  
 11 (3.37 pm)  
 12 (A short break)  
 13 (4.01 pm)  
 14 THE CHAIRMAN: Welcome back, everyone. So I see that,  
 15 Mr Rae, you're at the podium, and you are going to speak  
 16 to us on the questions relating to pondage. So whenever  
 17 you're ready, why don't you proceed.  
 18 Submissions on Engineering Issues Relevant to Pondage  
 19 MR RAE: (Slide 1) Thank you, Mr Chairman, members of the  
 20 Court. As you say, I am here before you today to  
 21 provide a response to several of the questions  
 22 concerning maximum allowable pondage.  
 23 We have divided the questions between Dr Miles and  
 24 myself, and my role is to provide any technical  
 25 explanations and elaborations where appropriate.

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16:02 1 (Slide 3) So this diagram was presented by Dr Morris  
 2 and Dr Miles last week to illustrate the variability of  
 3 the river flow in the Himalayan region. You will recall  
 4 that it shows the annual flow of the Neelum River at the  
 5 site of the Neelum-Jhelum hydropower station between  
 6 2019 and 2023. However, we can also use this to  
 7 illustrate the meaning of the firm and secondary power.  
 8 The diagram shows the variation in the river flow  
 9 rate through a period of four years. In my presentation  
 10 last week, I stated that firm power and firm energy are  
 11 inputs to any generation planning analysis. In essence,  
 12 they determine how much of the demand forecast can be  
 13 reliably provided by any given power station.  
 14 In terms of a run-of-river hydropower, there is no  
 15 regulation of the annual stream flow. So without  
 16 regulation, the firm capabilities of power and energy  
 17 are provided from the minimums of the flow record, in  
 18 this case for the Neelum River, and this is illustrated  
 19 by the lower horizontal line that I just added to the  
 20 figure.  
 21 I will try to point to some things here, but I must  
 22 apologise: there is a bit of lag in the movement but you  
 23 see the cursor.  
 24 The lower horizontal line is not the absolute  
 25 minimum, but it's sufficiently low for the illustration.

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<p>16:04 1 The firm power is then determined from a flow rate that 2 is reliably provided all year, so something close to 3 this minimum line across the bottom, and it's the firm 4 power which goes into the appraisal of the project's 5 economic capacity benefit. 6 The installed capacity is the higher line, and 7 excuse the lag, it's a bit difficult, but it's the upper 8 red dashed line. This is the rated power of the power 9 station, the rated capacity or rated power of the power 10 station. 11 To answer a question that Dr Blackmore put to 12 Dr Miles, the installed capacity is determined by the 13 economic analysis that balances the marginal costs of 14 that capacity with the marginal benefits to optimise the 15 capacity. The benefits include any higher energy 16 production obtained with secondary power that's 17 available -- this is mainly during the wet season -- and 18 the value of that energy to the power system. The 19 capacity benefit in the economic analysis is limited to 20 the firm power, which is the lower line at the bottom. 21 The difference between the installed capacity and 22 firm power is secondary power, which is indicated by the 23 arrow here. It's the margin between the two. The 24 secondary power enables the power station to produce 25 secondary energy when flow is available, and the</p> <p style="text-align: center;">Page 61</p>	<p>16:07 1 So as to the first point, it's the question of "the 2 potential relevance of Secondary Power, in particular, 3 in the context of Paragraph 8(b) of Annexure D". 4 As I illustrated in the previous slide, this 5 secondary power enables production of energy during 6 periods when the flow rate exceeds the flow rate used 7 for computation of firm power. The Treaty recognises 8 that secondary power is available, but does not provide 9 any criterion for its computation. As such, India can 10 define the installed capacity of the plant according to 11 their own economic optimisation. The sum of the 12 secondary power and the firm power is equal to the 13 installed capacity. 14 Paragraph 8(b) of Annexure D means that India is 15 permitted to have secondary power, but the subsequent 16 design criteria in paragraph 8 do not include any 17 reference to the secondary power itself. As 18 an engineer, I interpret paragraph 8(b) as providing 19 comfort in the face of paragraph 8(c). Paragraph 8(c) 20 makes clear that India may only fix its maximum pondage 21 by reference to firm power. But paragraph 8(b) makes 22 clear that even though the pondage at the plant may be 23 limited, there is nothing stopping India from designing 24 the plant with an eye to providing secondary power. 25 (Slide 5) Moving on to 26(b), which is simply</p> <p style="text-align: center;">Page 63</p>
<p>16:05 1 secondary power also enables dispatch of more power to 2 the system during periods when peaking is possible with 3 the available energy. Effectively, the secondary power 4 is used for peaking at any time of the year, and serves 5 to capture more energy in the wet season. 6 I've dealt with many hydropower feasibility studies 7 over the years where a key output of our analysis was 8 the assessment of the firm capabilities of the plant 9 within a detailed generation expansion planning context, 10 or as stand-alone projects where the project is small 11 relative to the power system. The information obtained 12 from these analyses is used in the economic and 13 financial analysis of project viability, and the terms 14 involved are precisely what I'm demonstrating to you 15 here. 16 (Slide 4) So with that background, I can provide 17 a response to a couple of the specific questions. And 18 looking first at question 26(a). 19 In my experience, it's always important to be very 20 precise in the definition of the terms and the 21 application in the various stages of the analysis. The 22 technical terms that we use have very precise meanings, 23 and it's important to be consistent in the use of the 24 terminology and to understand the precision, so that 25 they're applied correctly.</p> <p style="text-align: center;">Page 62</p>	<p>16:08 1 "how it" -- this is referring to secondary power -- 2 "interacts with [the] Firm Power". 3 The installed capacity of the power station is, in 4 broad terms, equal to the sum of the firm power and the 5 secondary power. The two values interact according to 6 that simple summation. 7 Firm power is determined from the specific 8 definition in the Treaty, given as paragraph 2(i) of 9 Annexure D. And the secondary power is determined by 10 India based on their analysis of the optimum installed 11 capacity. 12 Keep in mind that each of the three terms I'm using 13 here is the power given in megawatts. And the 14 terminology of the Treaty is consistent in respect of 15 the use of power, as I will explain in a few moments, 16 coming forward. 17 (Slide 6) The third and fourth points in the 18 question are related, and they deal with the duration of 19 the firm and secondary power, and the timing of that 20 power within the year. 21 (Slide 7) In order to answer this, I'm going back to 22 the annual hydrographs. And this is again the daily 23 flows available at Neelum-Jhelum. 24 As we can see here, the firm power is available -- 25 the lag is a bit annoying, but bear with me -- firm</p> <p style="text-align: center;">Page 64</p>

16:10 1 power is available throughout the year, and it is the  
 2 predominant amount available in the dry seasons.  
 3 Secondary power occurs any time that the flow exceeds  
 4 the minimum mean discharge required for calculation of  
 5 the firm power.  
 6 Note that the secondary power can be used by India  
 7 during low-flow periods with the available pondage.  
 8 This is a flexibility made available to India within the  
 9 terms of the Treaty. The energy available on any day  
 10 may be dispatched to the power system at more than the  
 11 firm power if the operator opts to use the secondary  
 12 power in place of the firm power. If a run-of-river  
 13 project has no pondage, then secondary power would not  
 14 be available in the low-flow periods.  
 15 (Slide 8) Again, to give a little bit more context,  
 16 I'm including this slide to give a quick illustration of  
 17 the frequency of occurrence of firm power and secondary  
 18 power. This is a screen capture of a spreadsheet that  
 19 gives the ten-day mean discharges for the Kiru  
 20 hydropower project, and the years are shown as you go  
 21 from left to right across the diagram and the ten-day  
 22 periods are read vertically in the columns.  
 23 And I don't expect anyone to be able to read this  
 24 data shown on the slide, but it has been provided by  
 25 Pakistan in Appendix E1 of its Memorial.

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16:13 1 for you.  
 2 DR BLACKMORE: Which you just answered. I just thought  
 3 it would be clearer if, when you have partial secondary,  
 4 you've got firm power plus partial secondary; and then  
 5 for the second or the third box on the right, you've got  
 6 firm power plus all of secondary power.  
 7 MR RAE: You're absolutely correct. The yellow and green,  
 8 you're getting firm and a portion of secondary.  
 9 DR BLACKMORE: Yes.  
 10 MR RAE: So, absolutely correct.  
 11 THE CHAIRMAN: It's very clever to answer the question  
 12 before it has been asked!  
 13 MR RAE: (Slide 9) So if I go forward, the firm power is  
 14 available at any time when the flow is at or below the  
 15 minimum mean discharge. And as Dr Blackmore correctly  
 16 observes, firm power is actually available throughout  
 17 the year. The secondary power is a margin on top of the  
 18 firm power which is available any time the flow rate is  
 19 greater than the minimum mean discharge. And the  
 20 pondage enables secondary power to be used in any period  
 21 by adjusting the duration of the generation with the  
 22 available energy.  
 23 I have illustrated this using ten-day mean flows for  
 24 convenience, given that you can't read the diagram.  
 25 It's still more convenient than looking at dailies. The

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16:11 1 What I've done here is to set the formatting so that  
 2 all ten-day periods with flow less than the minimum mean  
 3 discharge are shown in pink. I trust nobody is terribly  
 4 colour-blind. If the flow is above the minimum mean  
 5 discharge but less than the installed capacity, it shows  
 6 in the yellow colour. Secondary power is available for  
 7 some time, or at part-load, during any of the periods  
 8 identified in yellow. Flows above the installed  
 9 capacity are in green, at which time the full amount of  
 10 secondary power is available.  
 11 So secondary power is available in any of the  
 12 ten-day periods that are shown in yellow or green, so it  
 13 is quite a continuous part of the year. This is a very  
 14 simplistic representation, but illustrates that  
 15 secondary power is available frequently. The low-flow  
 16 periods below the minimum mean discharge do occur  
 17 frequently in the dry season, perhaps about 10% of the  
 18 time in a given year, although it varies, especially in  
 19 a wet or dry year.  
 20 Pondage, in Pakistan's interpretation of the Treaty,  
 21 is computed to ensure that India has access to the firm  
 22 power in these low-flow periods which are indicated in  
 23 pink, while firm plus secondary is available in the  
 24 yellow and green zones.  
 25 THE CHAIRMAN: Mr Rae, we have a question from Dr Blackmore

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16:15 1 actual conditions will be determined looking at the  
 2 daily flows. And you should note that the daily flows  
 3 have greater variability than the ten-day mean flows, so  
 4 you would see a greater frequency of the days below  
 5 minimum mean discharge.  
 6 However, this is consistent with the Treaty by  
 7 recognising that the "available only during certain  
 8 parts of the year" description appended to secondary  
 9 power is not bounded in the terms of its expected  
 10 timing, but it is available for significant parts of the  
 11 year, with the firm power being limited by low flows is  
 12 a much shorter part of the year.  
 13 (Slide 10) So this takes me to question 21. And the  
 14 question is:  
 15 "What is the relationship between Firm Power and  
 16 firm capacity?"  
 17 This refers to the terminology used in the Treaty  
 18 and makes comparison to similar terminology used in some  
 19 reference texts.  
 20 The use of "power" and "capacity" as terms is often  
 21 interchangeable. Both express the ability to do work at  
 22 a certain rate.  
 23 I'd like to point out that the Treaty does not use  
 24 the term "capacity" in the context of power stations.  
 25 "Capacity" in the Treaty is only used in relation to

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<p>16:16 1 quantities such as storage capacity or hydraulic 2 capacity. 3 The one reference to capacity for the power 4 facilities is given in Appendix II to Annexure D and in 5 the corresponding appendix to Annexure E, describing 6 data to be provided by India, which states: 7 "Maximum aggregate capacity of power units ... 8 Firm Power and Secondary Power." 9 This is one of the items to be delivered. 10 The use of the term here denotes the sum of the firm 11 power and the secondary power, which is of course the 12 installed capacity, which term is itself not included in 13 the Treaty. 14 (Slide 11) So on review of the transcript, the 15 actual question arises from the use of the term "firm 16 capacity" in the reference by Creager and Justin. And 17 I've excerpted a piece of the relevant text here from 18 page 262 of Creager and Justin. 19 Here we can see that in the first part of the text, 20 the wording refers to firm capacity being the portion of 21 the installed capacity that can perform the same 22 function as an alternative steam plant. I described 23 this process as part of my earlier presentation, where 24 a hydropower plant is evaluated relative to 25 an equivalent thermal power plant counterfactual or</p> <p style="text-align: center;">Page 69</p>	<p>16:19 1 I would have you recall here that Creager and Justin was 2 written at a time when isolated power grids were more 3 common, rather than our existing integrated grid 4 systems. And I discussed this in some detail in the 5 presentation last week. 6 In summary then, the two terms can be considered 7 interchangeable in engineering parlance, but that does 8 not inform the meaning of "Firm Power" within the 9 Treaty, which provides a bespoke definition of the 10 concept. This will become clearer when I move on to the 11 next question. 12 Picking up another point of discussion during the 13 week, Creager and Justin do refer to weekly computations 14 in some parts of their text. However, this is in line 15 with a description of the range of possible alternatives 16 from run-of-river without pondage, run-of-river with 17 varying amounts of pondage, and ultimately hydropower 18 projects with significant storage. The text in the 19 reference doesn't provide any specific requirement for 20 pondage, except in the context of what the plant can 21 contribute to the power system. 22 (Slide 12) In respect of question 22, this is 23 asking: 24 "Can [we] explain the basis for [the] position that 25 [the] Firm Power is ... calculated by reference to the</p> <p style="text-align: center;">Page 71</p>
<p>16:17 1 a thermal power plant alternative. 2 The second part of the reference of interest starts 3 at the paragraph here (indicating). It refers to the 4 capacity being related to the minimum stream flow at the 5 time of the peak load, the pondage, the installed 6 capacity, the load curve and the interrelationship to 7 other plants. The reference to pondage is here because 8 the firm capacity is determined from the flow rate 9 available and the volume of pondage for scheduling the 10 capacity through a day. The relationship to other 11 plants in this context is to determine the total power 12 system capability as each plant is added. 13 And keep in mind, as I referred to my previous 14 presentation, the firm capacity at any time is the 15 marginal capability of the power system when the 16 specified power station is added to the overall power 17 system. As such, it shows how much the power system 18 overall changes when a power station is added. The 19 concept of "marginal capability" recognises whether 20 a plant provides more capability to the power system 21 than the plant appears to contribute on its own, because 22 of the timing of generation. 23 The use of the load curve in this text was relevant 24 to ensure that the load was available to absorb all 25 power and energy produced as the plant is added.</p> <p style="text-align: center;">Page 70</p>	<p>16:20 1 power ... generated instantaneously, and not power 2 averaged over a period, for example one day?" 3 And question 22 requires clarification of the 4 terminology used in the Treaty and how it is expressed 5 in engineering usage. 6 Power in general is the rate of transferring energy 7 and is measured in watts. A watt is the International 8 System of Units unit for power; International System of 9 Units being the modern version of the metric system. 10 And 1 watt is equal to 1 joule per second. The joule, 11 correspondingly, is the unit for energy, which is equal 12 to the work done by a unit force acting through a unit 13 distance. 14 When Dr Miles referred to "instantaneous power", 15 he was making the point that power is a rate, not 16 an absolute amount or volume, like energy. It can be 17 useful to note here that power would be analogous to 18 a flow rate in hydrology, whereas the energy would be 19 analogous to the flow volume. Another analogy would be 20 to a car's speed versus the distance travelled in 21 a given amount of time. Power and energy fit 22 analogously to either of those. 23 When I recall the discussion from the transcript of 24 the specific exchange, the confusion appears to arise in 25 that the power referred to in the question has been</p> <p style="text-align: center;">Page 72</p>

16:22 1 taken as energy, so deals with the aggregate amount over  
 2 a period of time, rather than the rate.  
 3 (Slide 13) So this comes to the next issue. And  
 4 reference to the Treaty provides some clarity in this  
 5 matter. Annexure D, paragraph 2(i) gives us the  
 6 definition of "Firm Power". And I'll go through this  
 7 from the perspective of a hydropower engineer. If  
 8 further legal interpretation is required, it may be  
 9 taken up by Dr Miles tomorrow.  
 10 But if we look at the definition, it firstly tells  
 11 us that we are computing the hydroelectric power. So  
 12 the definition simply says:  
 13 "Firm Power' means the hydro-electric power ..."  
 14 And continues. The next thing it tells us, it gives  
 15 us a flow rate to use in the computation, which is the  
 16 minimum mean discharge.  
 17 Once we have determined that it is hydroelectric  
 18 power, the form of the equation that I show here  
 19 applies. The equation has several terms, and this was  
 20 presented to you earlier by Dr Miles. But the other  
 21 terms are: the mass density of water and gravitational  
 22 acceleration. These are natural parameters, not  
 23 variable by either party. Efficiency of the generating  
 24 units, where the turbines, generators, transformers,  
 25 et cetera, are specific to the hydropower business, and

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16:25 1 "firm capacity". If I understood you correctly, you  
 2 said that "firm power" and "firm capacity" are terms  
 3 that can be used interchangeably. Does that also then  
 4 relate to the redefinition of "Firm Power" in the  
 5 Treaty? Under that specific Treaty definition of "Firm  
 6 Power", should that then also keep -- does that also  
 7 mean that "firm capacity" is therefore also redefined?  
 8 MR RAE: Well, I did mention that "firm capacity" is not  
 9 given in the Treaty.  
 10 PROFESSOR BUYTAERT: No. But given that you said that  
 11 "firm power" and "firm capacity" are two terms that are  
 12 used interchangeably, which here you mean that they're  
 13 essentially synonyms. Then with "Firm Power" in the  
 14 Treaty is --  
 15 MR RAE: Not quite. What I'm saying is they're often used  
 16 interchangeably. And different texts will give them  
 17 different definitions, but they're then consistent  
 18 within their own use.  
 19 What I'm saying here is that we have a specific  
 20 bespoke definition which is applicable to the Treaty,  
 21 and we must be careful to deal with that definition  
 22 precisely, both in terms of what it includes and how  
 23 it is calculated. And then its purpose within the  
 24 Treaty is what we're interested in following up. I'm  
 25 very reluctant to start bringing in extraneous terms

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16:23 1 they would be known by having defined the power as  
 2 hydroelectric power.  
 3 The only other piece of information not in the  
 4 formula is the generating head. Well, the generating  
 5 head is known in the definition by relating the power to  
 6 being at the site of the plant. The topography of  
 7 a particular site will determine the head available for  
 8 any arrangement proposed.  
 9 So once we've set those items, looking at the  
 10 definition, there is no further information to be had.  
 11 So we are left with the result that is computed with the  
 12 definitions equal to a watt; that is, the power times  
 13 density times gravity times head times efficiency. You  
 14 combine those terms together and you get the dimensions  
 15 of a watt, which is what I show on the other side of the  
 16 slide, which I don't think is necessary to go through.  
 17 But a watt is a kilogram metre squared per second  
 18 cubed, in the International System of Units. And this,  
 19 when you go through the equation, is what you end up  
 20 with.  
 21 THE CHAIRMAN: Mr Rae, a question here from  
 22 Professor Buytaert.  
 23 PROFESSOR BUYTAERT: Mr Rae, actually, two questions, if  
 24 you don't mind.  
 25 The first question goes back to the definition of

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16:26 1 that are not given in the Treaty.  
 2 PROFESSOR BUYTAERT: Okay, thank you.  
 3 Then now on this slide (13), one assumption you seem  
 4 to make -- and please do correct me if that's wrong --  
 5 is that obviously the power equation relates to the flow  
 6 through the turbines, so therefore through the plant  
 7 itself, while the definition in the Treaty mentions that  
 8 it's the minimum mean discharge at the site of the  
 9 plant. So does that mean that you treat this discharge  
 10 at the site of the plant as being equal to the discharge  
 11 through the plant?  
 12 MR RAE: Correct, in the sense that it's referring  
 13 specifically to minimum mean discharge. And keep in  
 14 mind that the definition then continues, in the part  
 15 which I haven't excerpted here, to give the specific  
 16 procedure for calculation of the minimum mean discharge,  
 17 which arrives at a single value of: minimum mean  
 18 discharge equals X amount in cubic metres per second.  
 19 PROFESSOR BUYTAERT: So in this case, could it then have  
 20 been reformulated as "the hydroelectric power  
 21 corresponding to the minimum mean discharge through the  
 22 plant or through the turbines", rather than just  
 23 mentioning "at the site of [the] plant"? I can imagine  
 24 India, for instance, arguing that that simply means the  
 25 inflow, and not necessarily the same instantaneously as

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16:28 1 the discharge through the turbines of the plant, which  
 2 of course is what feeds into the hydropower equation.  
 3 MR RAE: No, the definition here is quite clear. It's firm  
 4 power is at the minimum mean discharge. And of course,  
 5 for calculating power through a turbine, so that means  
 6 the minimum mean discharge is passing through the  
 7 turbine.  
 8 PROFESSOR BUYTAERT: Okay, thank you.  
 9 THE CHAIRMAN: Mr Minear.  
 10 MR MINEAR: Just for clarity, could you repeat the  
 11 significance of the phrase "at the site of a plant" in  
 12 this definition?  
 13 MR RAE: Yes. For me, for my interpretation of this, "at  
 14 the site of [the] plant" gives us a physical location  
 15 for the plant, from which we have the topography  
 16 available, if they planned to put a dam or a power  
 17 station located some distance away. That physical  
 18 information will give you the head from upstream to  
 19 downstream, as you determine or lay out within that  
 20 site.  
 21 MR MINEAR: Thank you.  
 22 THE CHAIRMAN: So Mr Rae, if I can just follow up on these  
 23 questions a little bit.  
 24 Your presentation is on "Engineering issues relevant  
 25 to pondage". Do I understand correctly that in

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16:30 1 saying that we're dealing with power in watts, or  
 2 megawatts. And the Treaty has expressed that as  
 3 a specific item, and that tells us how we're to deal  
 4 with or how we can deal with that amount later.  
 5 If the Treaty had wanted to deal with flow volume,  
 6 it would have been precise and would have said "flow  
 7 volume". But the Treaty hasn't said that. It said  
 8 "power", which is a rate of energy production.  
 9 So when we come -- and we will come to the  
 10 calculation of pondage coming up here, and we can  
 11 demonstrate or discuss a little bit more around that  
 12 aspect as we go forward.  
 13 THE CHAIRMAN: But -- I won't pursue this too much further,  
 14 although Mr Minear may want to -- am I correct that  
 15 it doesn't matter what the fluid mass density is for  
 16 purpose of calculating pondage, it doesn't matter what  
 17 the acceleration of gravity is, or efficiencies are, at  
 18 this particular site: none of that makes any difference  
 19 when it comes to calculating pondage?  
 20 MR RAE: Effectively, no, it doesn't. And all of the  
 21 calculations that have been done, whether by Pakistan or  
 22 by India, come to the same realisation. So this is not  
 23 a unique observation. I believe our Memorial even says  
 24 as much.  
 25 THE CHAIRMAN: Mr Minear.

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16:29 1 Pakistan's approach to calculating pondage, the  
 2 equations you have up on the screen right now are  
 3 irrelevant?  
 4 MR RAE: You said "irrelevant"?  
 5 THE CHAIRMAN: I said "irrelevant" because in my  
 6 understanding of the way that Pakistan is approaching  
 7 the calculation of pondage, it's purely driven by the  
 8 MMD, with some calculations, but it has nothing to do  
 9 with the fluid mass density, the acceleration of  
 10 gravity, et cetera.  
 11 MR RAE: We have to look at what the Treaty says, and the  
 12 Treaty puts it in the context of firm power. So we go  
 13 through the calculations carrying firm power through.  
 14 And if at some point the various terms cancel out of the  
 15 calculation I think is what you're referring to: and  
 16 yes, they do, for the most part, cancel out of the  
 17 equation in the end.  
 18 THE CHAIRMAN: Well, just my understanding, but I'm happy  
 19 to be corrected: it's not a question of cancelling out,  
 20 it's a question of being irrelevant. You could for any  
 21 given hydroelectric plant, under Pakistan's approach,  
 22 take the MMD and multiply it basically by six hours of  
 23 flow to equal pondage, without needing to go to any of  
 24 these variables that you have up on the screen.  
 25 MR RAE: Yes, but the clarity that Treaty is giving us is

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16:32 1 MR MINEAR: Again, I just want to return to the Chair's  
 2 question here. I think it might relate to some things  
 3 that were said in Appendix E2.  
 4 But fundamentally, the critical variable here is  
 5 [minimum] mean discharge, to determine pondage; is that  
 6 right?  
 7 MR RAE: Yes.  
 8 MR MINEAR: And the other factors are not variable -- by and  
 9 large, they're going to be fixed -- and it's only the  
 10 [minimum] mean discharge which is going to lead to  
 11 a variation in the calculation of maximum pondage.  
 12 Is that correct?  
 13 MR RAE: That is correct.  
 14 Now, the reason to present this is to illustrate to  
 15 you -- and there's a logic to my thought here. We're  
 16 illustrating to you firm power, how it is defined in the  
 17 Treaty and calculated. And it is clearly power as  
 18 a rate; it is not energy as a quantity of production.  
 19 Because when we look at the definition, I've given you  
 20 the various terms that are coming from the words in  
 21 a precise way, but there is no reference to any time  
 22 anywhere in this definition.  
 23 So we're able to deal with firm power knowing that  
 24 it's a rate, and then we take that forward to deal with  
 25 calculation of pondage. Knowing what firm power is,

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16:33 1 we're able to convert precisely to the appropriate terms  
 2 for calculating the pondage. And I'll just come to how  
 3 that works when we go through the definition of pondage.  
 4 THE CHAIRMAN: Professor Buytaert.  
 5 PROFESSOR BUYTAERT: Mr Rae, following up on that.  
 6 You say that there is no explicit time period that  
 7 is considered, but obviously the minimum mean discharge  
 8 is expressed as a daily value; well, daily and later  
 9 ten days. Therefore, might it make sense to consider  
 10 the power production at that same timeframe and, for  
 11 example, consider the average power that has been  
 12 produced over a day, not taking into account intra-day  
 13 variations as they are being levelled out by pondage?  
 14 MR RAE: Yes, keep in mind that minimum mean discharge,  
 15 following the calculation given in the remainder of  
 16 2(i), results in a value in cubic metres per second.  
 17 Again, it's giving a discharge rate; it's not giving  
 18 a discharge volume. And Dr Miles did go through  
 19 an analysis of different time periods in the Treaty and  
 20 how they apply to the calculation of pondage, and  
 21 I would refer back to those discussions.  
 22 But we do in the end, as you point out, come back to  
 23 a 24-hour period as being most appropriate for the  
 24 consideration of the pondage. But that only informs how  
 25 we do the computation, by taking a rate times a time to

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16:36 1 PROFESSOR BUYTAERT: But in some scientific literature,  
 2 firm power is sometimes referred to as the average power  
 3 over a critical period: for example, a day. Would that  
 4 be a definition that is incompatible with this phrasing?  
 5 MR RAE: It would, because there's a precise definition  
 6 given here. And the precision of the Treaty requires  
 7 that we follow the precise definition here, and  
 8 we shouldn't be bringing in extraneous information that  
 9 has the end result of weakening the precision of the  
 10 document that we're faced with.  
 11 PROFESSOR BUYTAERT: Okay, thank you.  
 12 THE CHAIRMAN: Thank you, Mr Rae. Please proceed.  
 13 MR RAE: So the conclusion with respect to question 22 --  
 14 I hope I'm at this point -- is that Pakistan's position  
 15 for the computation of firm power is expressed by the  
 16 definition on the screen here from Annexure D,  
 17 paragraph 2(i). And again, "power" is a precise term in  
 18 the hydropower engineering industry and must be used  
 19 precisely as it is defined in the Treaty.  
 20 (Slide 14) So that brings us to question 23,  
 21 which is:  
 22 "How should the term 'Firm Power' be interpreted in  
 23 the light of the ordinary meaning of the term? [And]  
 24 Why was this term chosen given that ... it could have  
 25 been called something else if it didn't already have

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16:35 1 give us a volume; and then we allocate its use at the  
 2 firm power, or, as you point out, at the rate of the  
 3 minimum mean discharge.  
 4 PROFESSOR BUYTAERT: Thank you. As a follow-up question,  
 5 again just making sure we come to grips with this, in  
 6 your interpretation, would a potential alternative  
 7 definition have been that, for example, firm power is  
 8 capped at the power produced by the minimum mean  
 9 discharge? That seems to me an interpretation of  
 10 the calculation that is presented in the Memorial.  
 11 MR RAE: Yes, but when I'm reading this as an engineer,  
 12 I don't see those words here.  
 13 PROFESSOR BUYTAERT: No, I'm just wondering whether that has  
 14 the equivalent meaning.  
 15 MR RAE: Yes, I don't think it's equivalent.  
 16 PROFESSOR BUYTAERT: Would you be able to elaborate as to  
 17 why not?  
 18 MR RAE: Well, again, it comes down to that we're dealing  
 19 with power as a rate. And if we want to deal with  
 20 a certain amount of energy, we have to add a time  
 21 parameter, which means how many hours or days or weeks  
 22 you have of generation time, to give the total energy in  
 23 that period. It's the rate times the time that gives  
 24 you the quantity: the same as the speed of your car  
 25 times the time gives you the distance travelled.

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16:38 1 a ... general meaning?"  
 2 Question 23 comes back to the purpose of "Firm  
 3 Power" in the Treaty and whether the use of a special  
 4 definition conflicts with this general meaning in  
 5 hydropower engineering practice.  
 6 In my previous presentation, I stated that in power  
 7 planning we use "firm power" as the power that can be  
 8 assured to be available for the power station. And this  
 9 is its ordinary meaning in hydropower, and especially in  
 10 power planning. And it was illustrated in the figure  
 11 shown earlier today.  
 12 (Slide 15) And that's again what we see here: it's  
 13 merely an amount of power that can be derived from  
 14 a relatively low value of the flow rate, although it's  
 15 not the lowest value of the flow rate by any means. In  
 16 this case, it's the minimum mean discharge.  
 17 So in usual hydroengineering parlance, the "firm  
 18 power" is different from the "firm energy", although  
 19 both are computed from an analysis of the hydrological  
 20 record.  
 21 The Treaty provides a special meaning for the  
 22 computation of "Firm Power", which is what I've  
 23 illustrated just previously, and this special meaning  
 24 establishes its method of computation. So confusion may  
 25 arise if the "Firm Power" in the Treaty is being read as

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<p>1 "firm power for a fixed period", which converts the                  2 power to an amount of energy. And this approach was and                  3 is taken by India in their computation of pondage, as                  4 Dr Miles demonstrated.                  5 However, as an experienced engineer reading the                  6 Treaty, what is clearly given here is firm power as                  7 an amount in megawatts, which is the rate computed                  8 according to the definition specifically given in                  9 paragraph 2(i) of Annexure D.                  10 So I don't believe that the "Firm Power" is in                  11 conflict with this normal meaning, but the means for its                  12 calculation is short-circuited from the norm by pegging                  13 it to the minimum mean discharge. And no extraneous                  14 information is required to interpret "Firm Power" from                  15 the Treaty.                  16 (Slide 16) If I can move on to question 27. This                  17 requests information on the prevalence of low flows over                  18 a period of 25 years at the Kiru and Neelum-Jhelum                  19 sites.                  20 Firstly though, I think it's important to clarify                  21 the question, or how I interpret the question.                  22 Pakistan's calculation of pondage is designed to                  23 achieve the firm power under all operating conditions.                  24 If the flow rate is above the minimum mean discharge,                  25 then firm power is available by default. If the flow</p> <p style="text-align: center;">Page 85</p>	<p>16:42 1 (Slide 18) The Court has requested an analysis of                  2 pondage assuming a seven-day cycle. And again,                  3 a response here requires some explanation of the                  4 assumptions that are required to develop various                  5 alternatives for the computation of pondage. Any                  6 seven-day alternative we have considered includes                  7 foundational assumptions that would be at odds with the                  8 terms of the Treaty as interpreted by an experienced                  9 engineer.                  10 That said, I will attempt to summarise some of the                  11 various approaches that we have considered during                  12 preparation of Pakistan's Memorial. And in this process                  13 we looked at various positions taken previously, as well                  14 as the conclusions of the Neutral Expert in the Baglihar                  15 case. We then made an objective review of the Treaty,                  16 essentially starting with a blank sheet to see what                  17 options might be considered.                  18 (Slide 19) To start this, I'd like to recap the                  19 approach presented by Pakistan in the Memorial. The                  20 basic foundational premise of the approach is: that firm                  21 power is assured for any flow condition, or any daily                  22 flow condition; the flow rate and the volume available                  23 on any day is an outcome of the natural hydrology of the                  24 site; this volume determines the energy available on any                  25 day.</p> <p style="text-align: center;">Page 87</p>
<p>16:40 1 rate is at any level below the minimum mean discharge,                  2 then the firm power is provided by allowing sufficient                  3 pondage for the plant to operate, with the number of                  4 generating hours determined depending on the actual flow                  5 rate of the river.                  6 The methodology does not preselect a flow rate. The                  7 flow equivalent of the pondage is an outcome of the                  8 analysis. And I'll go through the analysis again in                  9 just a moment.                  10 (Slide 17) But first, the slide here shows the daily                  11 flow duration curve for the Kiru site, and from this                  12 we can observe that the flow rate is less than the                  13 minimum mean discharge on about 13% of the days. And on                  14 these days, the firm power is available, regardless of                  15 the flow rate in the river, by using the amount of                  16 pondage that we define in the analysis.                  17 The use of the pondage is not limited to a threshold                  18 of, say, 50% of the minimum mean discharge, as suggested                  19 in the equation. This is only an outcome of the                  20 analysis and does not place any restrictions on the                  21 ability to produce firm power during these periods.                  22 I didn't have the data available for Neelum-Jhelum                  23 immediately, but the relationship would be similar to                  24 what we see here: that the firm power will be active in                  25 the project between 100% and 80%, in general.</p> <p style="text-align: center;">Page 86</p>	<p>16:43 1 Knowing that the firm power is the power produced by                  2 a flow rate equal to the minimum mean discharge, we can                  3 determine the number of hours of generation on each day                  4 by dividing the available flow volume by the minimum                  5 mean discharge flow rate, which is precisely the                  6 observation that the Chairman has made. The pondage is                  7 then calculated once a daily dispatch schedule is                  8 created with the daily generating hours.                  9 I'd like to point out here that the Treaty does not                  10 make any provision for the use of installed capacity or                  11 secondary power in the calculation of pondage. The                  12 pondage only refers to the calculation of firm power in                  13 paragraph 8(c) of Annexure D.                  14 In the approach presented by Pakistan in the                  15 Baglihar dispute, the analysis was also based on this                  16 foundational premise that the firm power would be                  17 available, but this was interpreted as continuously                  18 during a week, with the pondage required to account for                  19 variations in natural inflow during the week.                  20 We had dropped this approach because the result is                  21 very sensitive to any errors in the hydrological data,                  22 such as abnormally high or low daily values. It also                  23 produced a range of potential values, and required                  24 an assumption that the firm power would be continuous                  25 for a 168-hour week, which is not supported by the</p> <p style="text-align: center;">Page 88</p>

16:45 1 language of the Treaty. And Dr Miles can speak to that  
 2 comment later on.  
 3 That said, let's look at how the calculation is  
 4 performed as presented in Pakistan's Memorial.  
 5 (Slide 20) So the details of the calculation are  
 6 included in Appendix E of the Memorial, where we give  
 7 various analytical methods for computation. The  
 8 principle is simply that the firm power is available for  
 9 dispatch on any day, regardless of the flow available in  
 10 the river. Note here that the energy available for  
 11 generation during the day is a function of the total  
 12 volume within that day. What the pondage is doing is  
 13 changing the natural flow rate of the river so that the  
 14 outflow rate is sufficient to provide the firm power,  
 15 which is also a rate.  
 16 This is illustrated by the simple graphic shown on  
 17 the slide here, where we have a fixed flow rate  
 18 available, which is the red line across the middle. The  
 19 total volume of water obtained from this flow rate over  
 20 24 hours can then be redistributed so that it is  
 21 released at the minimum mean discharge rate, which  
 22 produces the firm power.  
 23 I could also have presented this figure directly in  
 24 energy and shown the accumulation of energy and the use  
 25 of power. And I can equate one or the other, depending

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16:48 1 extended to a seven-day period. And my response is that  
 2 it does not have a direct extension to a seven day  
 3 equivalent. The methodology provides firm power on each  
 4 day as its foundational premise, and in our view, the  
 5 current methodology works both daily and weekly basis  
 6 already. India is provided with firm power every day,  
 7 and the energy available is a function of the hydrology  
 8 of the river at the site, which determines the duration  
 9 of the firm power within each day.  
 10 Once the firm power has been provided each day for  
 11 seven days, we have met the weekly requirement that firm  
 12 power is available for the week.  
 13 THE CHAIRMAN: Excuse me, Mr Rae. Mr Minear has a question.  
 14 MR MINEAR: Perhaps you should finish your thought and then  
 15 I'll ask my question.  
 16 MR RAE: Okay. I'll be brief.  
 17 So I was just going to say here that in response to  
 18 20(a), we're saying that there is no direct extension of  
 19 the methodology to seven days. And then I'm going to go  
 20 into some seven-day cycles in the following comments.  
 21 So perhaps your question -- this is good timing.  
 22 MR MINEAR: I think my question is best after you've offered  
 23 your explanation. You might answer my question in the  
 24 course. I think my question will be best posed after  
 25 you've finished your presentation on this topic, since

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16:46 1 on how the analysis is done.  
 2 But for any flow rate, the calculation requires  
 3 three steps.  
 4 Firstly, we calculate the firm power from  
 5 paragraph 2(i), as we discussed a few minutes ago.  
 6 Then we compute a daily peaking time. And this is  
 7 equal to the volume for the day at the actual flow rate  
 8 divided by the minimum mean discharge. This gives the  
 9 number of hours that the plant can operate to deliver  
 10 firm power for the available flow rate. The daily  
 11 generating time gives a dispatch schedule.  
 12 We can then compute the pondage from the inflow  
 13 volume that can accumulate during the hours when the  
 14 plant is not operating.  
 15 The plant will store water for part of the day and  
 16 release at the firm power rate for the remainder of the  
 17 day.  
 18 The rest of the calculations in Appendix E show how  
 19 the maximum pondage can be determined from the full  
 20 hydrological record. This can be done by simply  
 21 repeating the calculation described here for each day of  
 22 the hydrologic record, which we had done; or by using  
 23 the analytical method that we present in Appendix E,  
 24 which eliminates most of the computational effort.  
 25 So the Court has asked if this methodology could be

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16:49 1 you might answer my question in what you're about  
 2 to say.  
 3 MR RAE: Okay.  
 4 So any other extension to a seven-day cycle does  
 5 assume some aggregation and rescheduling of the flow  
 6 volume for the period, with the criteria being inferred  
 7 or assumed, rather than explicitly stated in the Treaty.  
 8 (Slide 21) So that said, we can actually create  
 9 various seven-day cycles, but each of these requires  
 10 making some assumptions. In the course of the  
 11 preparation of the Memorial, we developed several  
 12 alternative approaches, but each of these were  
 13 ultimately rejected as being unsupported by the terms of  
 14 the Treaty or being so complex as to be impractical for  
 15 application.  
 16 Most of the approaches also rely heavily on details  
 17 of the daily flow record, and in fact, the results are  
 18 very sensitive to the occurrence of errors or technical  
 19 discrepancies in the hydrological record. I should note  
 20 that in my experience, there are always errors in  
 21 a hydrological record, despite the best efforts of data  
 22 collection, analysis and quality control.  
 23 India and the Baglihar Neutral Expert have used very  
 24 simplified versions of the analysis that I'm going to  
 25 present to you today by effectively averaging flows over

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16:50 1 periods of time. But in all cases, Pakistan assumes  
 2 that the power is being dispatched at the firm power and  
 3 not at the installed capacity. And this is the major  
 4 point of difference from the methods proposed by India  
 5 or the result given by the Baglihar Neutral Expert.  
 6 I would note that the Treaty does not make any  
 7 provision for the installed capacity in paragraph 8 of  
 8 Annexure D, or for that matter in paragraph 15. The  
 9 only reference is to secondary power, which is not  
 10 linked to the computation of pondage. And for Treaty  
 11 interpretation, I'll refer this to Dr Miles tomorrow.  
 12 But any of the alternatives that I'm going to  
 13 illustrate are working drafts that are only to  
 14 illustrate the concepts developed and some of the  
 15 difficulties that we experienced. But we have developed  
 16 the concepts sufficiently to illustrate how the criteria  
 17 in the Treaty may affect their computation and any  
 18 supplementary assumptions that were needed, sensitivity  
 19 to data, and the uncertainty of the results coming out  
 20 of it.  
 21 So looking at it, alternatives fall into three main  
 22 categories. And there are sub-variants within these,  
 23 but I'm not going to go through all the sub-variants.  
 24 The first is scheduling arising from the application of  
 25 paragraph 8(c) alone; the second is when we combine 8(c)

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16:52 1 with paragraph 15; and the third is something where  
 2 we refer only to the use of a load duration curve.  
 3 (Slide 22) So in the first of these options -- I may  
 4 be repetitive, but I'm going to say again that we're  
 5 doing the daily peaking to generate at the firm power,  
 6 and the idea is to create a weekly schedule using only  
 7 paragraph 8(c) with the actual flow data. So the  
 8 methodology we developed involves selecting seven-day  
 9 sequences from the daily hydrological record. However,  
 10 this requires that the record is screened to select all  
 11 periods with at least some time below the minimum mean  
 12 discharge.  
 13 If you look at the whole year, you've got  
 14 358 possible seven-day sequences. Because if you  
 15 capture each seven days, you only move one day at a time  
 16 as you go to the next sequence. The sequence of flows  
 17 is important, and you've got to consider them all if  
 18 you're going to determine whether there's a maximum of  
 19 power involved. This can be reduced by only selecting  
 20 periods in the dry season, but that reduces the number  
 21 by about half. In practice, what we have done is set up  
 22 a series of macros, working in spreadsheets, to process  
 23 the data and select the periods.  
 24 So the next step in the process is that we calculate  
 25 the average flow rate for each of the seven-day periods,

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16:54 1 and from that we calculate the daily generating hours  
 2 using those seven-day flow volumes and the minimum mean  
 3 discharge. The daily generating hours are assumed to be  
 4 the same for each of the seven days, which introduces  
 5 a significant assumption into the calculation.  
 6 (Slide 23) So if I go on to see what it looks like.  
 7 This figure shows an example of a typical week. And of  
 8 course we have many, many weeks that can be displayed,  
 9 but this is a typical one.  
 10 Just to explain what we're looking at here -- and  
 11 I regret that the mouse doesn't work more quickly -- the  
 12 orange line shows the variation of pondage through the  
 13 week, which reads off the axis on the right-hand side.  
 14 The blue line shows the variability of the natural  
 15 inflow from day to day, and you can see here an example  
 16 where the flow more or less doubled from Thursday to  
 17 Friday. And the grey lines show the dispatch of the  
 18 power station at the firm power, or what's shown here is  
 19 the minimum mean discharge amount.  
 20 So the pondage calculations are performed each day.  
 21 But when we go through this, depending on the timing of  
 22 the flow rate, the actual flow, you can have negative  
 23 periods of pondage very early in the programme or you  
 24 can have periods when the pondage becomes negative  
 25 partway through the week. So you have to do the

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16:55 1 calculation once and then reset the storage condition at  
 2 the beginning, so that your pondage ends up at the same  
 3 at the beginning and the end of the period, or else you  
 4 end up with negative values which are not realistic.  
 5 So in doing the analysis, the pondage is computed in  
 6 all of the weeks, even if we have abnormally low days  
 7 within the weeks. And this means that the record can't  
 8 exclude any of the weeks simply because they have  
 9 an average less than the minimum mean discharge. You  
 10 may have low flows at the beginning of a week that would  
 11 require pondage, so we had to compute all of those  
 12 as well.  
 13 I say that just to note that the analysis involves  
 14 a large number of computations to arrive at the daily  
 15 loading analysis and the associated pondage. And we  
 16 have the opportunity, now that we can run this through  
 17 spreadsheets, so that I can do it reasonably quickly,  
 18 but it still involves analysis.  
 19 (Slide 24) When it comes to the result, what we get  
 20 from it is the relationship between the amount of  
 21 pondage required and the average flow rate in any  
 22 period. And this figure actually illustrates one of the  
 23 difficulties with the approach, and that is: we have  
 24 a whole series of values here which are very suspect.  
 25 When we calculate Pakistan's approach to daily

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16:57 1 pondage, it gives a curve which follows these data and  
 2 then loops around this way to zero. But it follows as  
 3 a lower bound to those data, the lower part.  
 4 But during analysis and examination of the results,  
 5 the higher pondage values were generally found to be  
 6 caused by suspect data in the hydrological record.  
 7 These are values that became abnormally low or  
 8 abnormally high within the record, that then skewed the  
 9 results and resulted in these what I consider as  
 10 outliers.  
 11 To go through the analysis, the scattered values  
 12 would have to be rejected as being unlikely to be valid.  
 13 But it requires corrections in the hydrologic record and  
 14 quality control review, which is not within Pakistan's  
 15 authority under the Treaty. We are given the data;  
 16 we are not able to correct it and screen it for quality  
 17 control. The process of screening at this level becomes  
 18 subjective, which adds another level of uncertainty to  
 19 the analysis.  
 20 So, in summary, we have a process of selecting  
 21 periods, coming to weekly distribution of the energy or  
 22 flow rate, computation of the pondage, and then the  
 23 adjustment of the pondage so that we never go to  
 24 a negative value in between. And there are, ultimately,  
 25 thousands of individual calculations which are done in

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17:00 1 development of this method would be more complex than  
 2 what I've described above or previously for the weekly  
 3 computation using paragraph 8(c) alone.  
 4 (Slide 26) So going to paragraph 15, we have the  
 5 operational requirements for flow balance. And  
 6 paragraph 15 does not refer to pondage but it does give  
 7 flow balances. The overall requirement is a balance  
 8 within a seven-day period. And this overriding  
 9 constraint applies to any location.  
 10 The second group of constraints is that the flow on  
 11 any day must be within minimum and maximum limits that  
 12 are computed for that day. And these limits are imposed  
 13 on the 24-hour flow volume, and not on any average daily  
 14 flow volume. And the daily flow limits vary depending  
 15 on the location of the power plant.  
 16 (Slide 27) Application of this method by the  
 17 Baglihar Neutral Expert and by India uses the average  
 18 flow through the seven days to give a weekly flow  
 19 balance. This is illustrated in this slide, which  
 20 compares the cumulative inflow with the cumulative  
 21 outflow. So effectively, anywhere on the curve, if you  
 22 reference the curve, it will give you the volume that  
 23 you have accumulated by any particular day of the week.  
 24 When we look at the terms of paragraph 15, that  
 25 requires, at a limit, not less than whether 30% or 50%

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16:59 1 macros within a spreadsheet.  
 2 We believe the method has several fatal flaws that  
 3 make it unacceptable for application. The first is that  
 4 it's very sensitive to data errors, and screening-out of  
 5 the erroneous results is time-consuming and subjective.  
 6 The Treaty does not provide any criterion supporting the  
 7 equal daily firm power periods. And the assumption of  
 8 average flow rate for the week is not supported by any  
 9 provision in the Treaty. And again, as I mentioned,  
 10 there's significant computational effort.  
 11 (Slide 25) We did look at a second method, which is  
 12 trying to combine paragraph 8(c) and paragraph 15. And  
 13 paragraph 15 requires that the flow volume received in  
 14 any seven-day period be released within that same  
 15 period.  
 16 But a second requirement -- and I think it's a very  
 17 important one -- is that the flow volume on any day must  
 18 be within 130% and 50% or 130% and 30%, depending on the  
 19 location in the watershed. But this variation is  
 20 balanced on the daily flow; it's not variation on  
 21 an average flow. And that detail would add significant  
 22 complexity to any computation.  
 23 What I am presenting for you here is a significant  
 24 simplification of the concept that I used as  
 25 a preliminary development. But in fact, the full

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17:02 1 of the flow on some of the days and 130% on the other.  
 2 And if you take these two rates in combination, you  
 3 would get the red curve shown below here, which  
 4 effectively divides the period into what is nominally  
 5 weekends versus weekdays, even though the weekend is  
 6 a little over two days.  
 7 But the flow rate here is indicated by the slope of  
 8 the lines, and then the curve is showing the volume.  
 9 The inflow, the blue line, is uniform in the assumption  
 10 that has been made by the Neutral Expert. And this is  
 11 the key difficulty with the analysis: you're making  
 12 an assumption of uniformity, rather than using the  
 13 actual daily flows implied by paragraph 15.  
 14 (Slide 28) Now, if we ignore that difficulty, we can  
 15 make a weekly schedule to assign the generating hours to  
 16 the flow volumes available from the paragraph 15 flow  
 17 balance. Now, what I'm showing here is a very, very  
 18 simplified version where I have taken the approach of  
 19 looking at the average flow, knowing that it's not  
 20 correct according to the interpretation that we make.  
 21 So the flow can be developed as a function of flow  
 22 rate, as we did in the previous alternative, and this is  
 23 one of the outputs. The daily generation time varies  
 24 between the Saturday and Monday period. So you see  
 25 the orange here are narrow periods of operation on the

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17:04 1 Saturday, Sunday and a shorter time period on Monday,  
 2 here (indicating). The remainder of the week, which is  
 3 the weekdays arising out of the previous slide, gets --  
 4 at this particular flow rate, it's operating at the full  
 5 firm power or minimum mean discharge amount.  
 6 If I were to show you a lower flow rate, what you  
 7 would see is that the Tuesday to Friday generating  
 8 periods would become less than 24 hours, but they would  
 9 also be capped at the firm power; but there would still  
 10 be generation on the Saturday, Sunday, Monday.  
 11 (Slide 29) But in the method, the pondage will  
 12 invariably reach a maximum at the end of the weekend,  
 13 which is the point where it's the peak here. That will  
 14 invariably be the maximum pondage during the week,  
 15 unless there is some extraordinary error in the  
 16 hydrology. So the pondage accumulates through the  
 17 weekend, reaches the maximum, and then declines through  
 18 the rest of the week as the water is drawn from storage.  
 19 Recall again that this is done with a uniform flow.  
 20 (Slide 30) What I show here in these curves is how  
 21 the result of this very simplified case would come if  
 22 you don't consider the actual daily flow data. The  
 23 weekly inflow is assumed to be uniform, and the number  
 24 of hours is then determined with the firm power  
 25 according to the minimum mean discharge. It gives

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17:07 1 And if we're imposing the actual daily flow data,  
 2 we would find that it is again extremely sensitive to  
 3 potential discrepancies in the hydrologic record, in the  
 4 same way it was in the previous example I gave.  
 5 On reflection of the difficulties involved, this  
 6 approach was dropped before being fully developed. The  
 7 combination of its complexity and potential subjectivity  
 8 in the face of data errors made any possible result  
 9 suspect.  
 10 (Slide 30) So I come to another completely different  
 11 approach, and that's that pondage can also be derived  
 12 directly from the daily load duration curve, although  
 13 this would be done for a daily analysis.  
 14 The analysis would adopt a load duration curve,  
 15 illustrated here as the orange line, and it shows simply  
 16 the percentage of time that the power exceeds a certain  
 17 amount. So the power on the left-hand axis, the  
 18 vertical axis, and the percentage of time on the  
 19 horizontal axis. And the orange curve at any point  
 20 shows the percentage of time that the power is exceeded.  
 21 The area under this curve is equal to the energy.  
 22 So the methodology using a load duration curve is  
 23 that we locate the position of a plant's firm power and  
 24 firm energy within the load duration curve so that both  
 25 elements are fully used. And this process is referred

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17:06 1 an amount of pondage, which is an outcome of the  
 2 operating criteria in paragraph 15. But the biggest  
 3 difficulty is that the daily flow rate is not considered  
 4 in the simplified version I demonstrate here.  
 5 If we were going to adhere to paragraph 15, that  
 6 would require that we include the daily flow rates so  
 7 that we can test the flow variability of each 24-hour  
 8 period within the constraints in paragraph 15. And if  
 9 the actual data values were used, then we would have the  
 10 same or more difficulty as identified for the previous  
 11 alternatives. We would need to compute the pondage for  
 12 each possible seven-day period within the generation  
 13 duration, varying the time depending on the seven-day  
 14 flow balance as well as the individual daily flow  
 15 bounds. And this added complexity became somewhat  
 16 intractable when I was going through these analyses some  
 17 months ago.  
 18 Again, you have over 300 possible seven-day periods  
 19 within each year, and the computation requires the  
 20 paragraph 15 limits to be considered before coming to  
 21 the generation time on a daily basis. Having made  
 22 a balance, the timing of the generation would also be  
 23 computed, and the whole result is then recomputed with  
 24 the pondage to ensure that you're not creating negative  
 25 values.

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17:09 1 to as "stacking", where each plant is assigned to the  
 2 load duration curve to meet the overall demand.  
 3 Looking at the bottom, this bottom bar, if I had  
 4 a certain amount of energy available from the plant,  
 5 I could distribute it through 24 hours, and that would  
 6 give me a certain amount of power required to give that  
 7 distribution. If that power is less than the firm  
 8 power, then we won't have made the best use of that  
 9 available capability.  
 10 The optimum position is to locate the place closer  
 11 to the top, as I illustrate here (indicating), where the  
 12 blue area underneath the curve, bound by this line, is  
 13 equal to the energy available across the bottom; and at  
 14 the same time, the power available on the left side is  
 15 equal to the firm power. So we take advantage of both  
 16 firm power and energy by locating its position within  
 17 the load duration curve.  
 18 But in order to do that placing at that upper  
 19 position, you need pondage. And in doing this analysis,  
 20 the observation is that if I took that original slice  
 21 and just moved it up, then the area of that slice  
 22 sitting to the right side of the load duration curve is  
 23 equal to the amount of energy storage I need in order to  
 24 place it under the load duration curve.  
 25 I know it's a bit complicated, but the geometry

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17:10 1 works. And the objective here is to find a combination  
 2 where you can make full use of the power and the energy,  
 3 which is the area under the curve, and you just find  
 4 where you are in the load duration curve to take  
 5 advantage of both components of that.  
 6 We note that the position where the plant will stack  
 7 in the load duration curve will vary as a function of  
 8 the flow rate. The lowest flow condition has the least  
 9 energy, and therefore will stack high in the load  
 10 duration curve. As the flow volume increases, the plant  
 11 stacks progressively lower until the plant becomes  
 12 baseload: it's available 24 hours.  
 13 The approach can be set out analytically based on  
 14 the characteristics of any power station and the load  
 15 duration curve. And we've gone through this process,  
 16 and several observations of the methodology include  
 17 that: the method is computationally sparse, it doesn't  
 18 require a lot of data handling or a lot of separate  
 19 computations; the maximum pondage is computed directly  
 20 from the minimum mean discharge or firm power, as we do  
 21 it with no other inputs; and there's no other  
 22 assumptions required, other than information  
 23 specifically given in the Treaty.  
 24 It provides firm power on any day, with the number  
 25 of hours of generation depending on the actual flow

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17:13 1 of them requires some assumptions that are not  
 2 explicitly stated in the Treaty, and they're required to  
 3 develop any of seven-day concepts.  
 4 All of the options are substantially computationally  
 5 intensive because of the need to deal with the daily  
 6 flow and to make the corrections. And any of the  
 7 simplifications that are taken that are going into the  
 8 analyses to make use of average flows during the  
 9 seven-day cycle are simply not supported by the language  
 10 of the Treaty. And Dr Miles may refer to that point  
 11 tomorrow.  
 12 The methods require a consideration of the sequence  
 13 of daily flows in the record, and that sequencing of  
 14 flows can result in irregularities in the results if  
 15 there's abnormal changes in flow from one day to the  
 16 next that are interpreted as data errors or simply  
 17 discrepancies that are unexplained.  
 18 The superposition of paragraph 8(c) and paragraph 15  
 19 would require more computational effort than what  
 20 I described for paragraph 8(c) on its own. But in  
 21 either case, the peaking is carried out using the firm  
 22 power for scheduling of the generation. The installed  
 23 capacity is not included anywhere in the Treaty and  
 24 accordingly is not part of the pondage computation.  
 25 We have developed the schemes indicated here

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17:12 1 rate. The maximum pondage would, however, be large  
 2 enough to enable production of firm power regardless of  
 3 the actual flow rate, so any flow could be served. It's  
 4 not sensitive to hydrological data discrepancies or  
 5 errors. And the result, interestingly, is not sensitive  
 6 to the shape of the load duration curve because the  
 7 plants being considered are small relative to the system  
 8 load.  
 9 This methodology was known at the time the Treaty  
 10 was prepared, and descriptions of elements of this are  
 11 given in the text by Creager and Justin and  
 12 contemporaneous references. But most interestingly the  
 13 pondage provided by this method reduces to exactly the  
 14 same analytical result as we've derived from the  
 15 analysis presented by Pakistan in our Memorial.  
 16 It's not a weekly scheduling, but it's  
 17 an illustration of the fact that there are other bases  
 18 for this calculation that are also useful.  
 19 (Slide 31) So to summarise on question 20(b), there  
 20 are other variants of the seven-day alternatives that  
 21 I've discussed that might be available. And certainly  
 22 to develop the combination of 8(c) and 15, we would have  
 23 to be developing a variant where we include the daily  
 24 flows and the variability of the daily flows: that's  
 25 essential for it to be a proper alternative. But each

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17:15 1 sufficiently so that the results could be identified.  
 2 But none of these schemes was ultimately considered to  
 3 be correct, because of both the lack of sufficient  
 4 support in the Treaty and because of the complexity  
 5 involved. After review, the Pakistan calculation  
 6 presented in the Memorial was selected as being  
 7 compliant with the Treaty, not requiring any external  
 8 information or assumptions, and being straightforward  
 9 to apply.  
 10 That brings me to the end of my prepared notes.  
 11 THE CHAIRMAN: Thank you very much, Mr Rae.  
 12 Let me turn to my colleagues. I have  
 13 Professor Buytaert first, and then Mr Minear.  
 14 (5.16 pm)  
 15 Questions from THE COURT  
 16 PROFESSOR BUYTAERT: Thank you, Mr Rae. Would you mind  
 17 going back to your previous slide, I think on ...  
 18 MR RAE: This one (slide 30)?  
 19 PROFESSOR BUYTAERT: Yes, here.  
 20 So you present there the upper blue bar, which you  
 21 called the "stored energy". Could you elaborate how  
 22 that energy is being calculated?  
 23 MR RAE: The calculation of the energy is from whatever flow  
 24 rate is available in the river on that day.  
 25 PROFESSOR BUYTAERT: Over a day?

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17:16 1 MR RAE: Yes.  
 2 PROFESSOR BUYTAERT: Okay.  
 3 MR RAE: You can do this daily, weekly, monthly, whichever  
 4 one is convenient. If you do it weekly, you end up with  
 5 a volume which is the total volume for the week, which  
 6 you then divide per day for pondage. But it's the flow  
 7 rate in the day times the number of hours in the period  
 8 gives you the energy.  
 9 PROFESSOR BUYTAERT: Thank you.  
 10 As a quick follow-up -- I know you've had very  
 11 little time to prepare this: we very much appreciate  
 12 that you went into so much detail -- but would there be  
 13 an opportunity of combining your method 2, which applies  
 14 the constraints of a 30% and a 130%, and allows for some  
 15 form of carry-forward during the weekend, with this  
 16 method?  
 17 MR RAE: That would be entering into a lot more complexity.  
 18 And when we do this sort of analysis, we typically do it  
 19 for a planning period over longer terms. To try to  
 20 create the complexity of dealing with the load duration  
 21 on weekends versus weekdays would have the same  
 22 difficulties, I think, as the other approach.  
 23 PROFESSOR BUYTAERT: But assuming -- under, for example,  
 24 method 2 -- that you have some idea of the weekly  
 25 variation between weekdays and weekends, it doesn't seem

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17:19 1 come back to recombine them.  
 2 PROFESSOR BUYTAERT: Okay, thank you.  
 3 THE CHAIRMAN: Mr Minear.  
 4 MR MINEAR: Mr Rae, thank you. I want to go back just to  
 5 make sure I have a good understanding of the position  
 6 that's stated in the Memorial as compared to India's  
 7 very different position.  
 8 I take it as a starting point that we have pondage  
 9 because of weekly and daily variations in load because  
 10 we live lifecycles that reflect that: we get up in the  
 11 morning, we go to work, we come home daily. Some of us  
 12 get the time off on the weekend; obviously not  
 13 Pakistan's legal team this week!  
 14 But those are concerns for a person who is operating  
 15 a hydropower plant. And they can take advantage of that  
 16 by stacking up pondage on the low-use weekends to use  
 17 during the high-peak demands during the middle of the  
 18 week. That's basically accepted, right? Am  
 19 I describing the basic situation for an operational  
 20 engineer correctly?  
 21 MR RAE: That is one possible use of pondage. But keep in  
 22 mind, as we look at the spectrum of run-of-river  
 23 projects or hydropower projects generally, we go from  
 24 projects which have zero pondage: basically, the water  
 25 level must be kept constant. And typical of those would

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17:18 1 to be too difficult to take this stored energy,  
 2 calculated obviously for the entire week, and then  
 3 redistribute it according to the data that you've used  
 4 in your method 2.  
 5 MR RAE: What I said was that when I go through the  
 6 mathematics of this and create the analytical process,  
 7 you end up with a computation which reduces to exactly  
 8 the same equation that we have produced coming out of  
 9 the analysis in the Memorial.  
 10 PROFESSOR BUYTAERT: I guess only if you do it on a daily  
 11 basis and don't carry over. So essentially, if you use  
 12 the blue bar, essentially the energy, that's the  
 13 potential energy that's available in the inflow. And if  
 14 you carry that over in the way that you did in your  
 15 method 2, you should be able to take into account or to  
 16 address some of the weekly variations that you showed in  
 17 your method 2.  
 18 MR RAE: What you're talking of doing though is splitting  
 19 the weekdays and weekends. Each will have their own  
 20 pondage. But then trying to unify those back together  
 21 in a maximum pondage permissible is where the problem  
 22 would come.  
 23 You can certainly split the load duration curve and  
 24 done the analysis on their own, but each will show their  
 25 own pondage. But they're not additive again when you

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17:20 1 be projects on the Ohio River or the Mississippi, where  
 2 navigation rules and they're not able to operate up and  
 3 down.  
 4 MR MINEAR: Sure. I'm not trying to trip you up on this,  
 5 just to be clear.  
 6 Just the general principle of pondage is that's  
 7 a practical concern for someone who's operating  
 8 a hydropower plant: you can take advantage of the low  
 9 usage during the weekend too. That's why the weekly  
 10 loads are important, because you can take advantage of  
 11 low usage on the weekend to, in essence, create more  
 12 pondage to use during the peak days later in the week.  
 13 MR RAE: Yes. What I wanted to say though is that we have  
 14 a spectrum. And whether you're able to use it on  
 15 a weekday/weekend analysis or you have a daily analysis  
 16 or you have no pondage at all depends where your project  
 17 falls on that spectrum.  
 18 MR MINEAR: Sure.  
 19 MR RAE: And it's still useful in between. And this is part  
 20 of what I put in my presentation last week: that the  
 21 pondage is still being used in the power system. So  
 22 it's still useful, no matter what the amount is: it's  
 23 still generating benefits for the power system.  
 24 But in principle, once you've computed the pondage,  
 25 whatever methodology is done, then you go into the

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17:22 1 definition of pondage and it tells you how you can  
 2 use it. And it may be used weekly and daily.  
 3 MR MINEAR: You're moving away from the point that I want to  
 4 make, that I think you might agree with; but if you  
 5 don't, I'd like to know that as well.  
 6 But these considerations you're talking about now,  
 7 and the general description of the use of pondage, are  
 8 matters that go to how one operates a plant, the person  
 9 who's actually in the plant operating it. But what  
 10 we're concerned with in the Treaty is the calculation of  
 11 maximum pondage based on a formula that's specified in  
 12 the Treaty. And that definition is not looking to how  
 13 you operate a plant: it's simply providing a number.  
 14 And the number is the same whether it's a Sunday,  
 15 Monday, Tuesday, Wednesday, under your theory, I think.  
 16 MR RAE: Yes.  
 17 MR MINEAR: But it's just a means for calculation, in the  
 18 same way that no one operates a plant 12 hours on,  
 19 12 hours off in that particular example you gave. They  
 20 might on a particular day, but it's a dynamic process in  
 21 operating the plant day to day. And what the Treaty  
 22 specifies is just a formula for calculating pondage,  
 23 which is not tied to how the operator is going to  
 24 operate the plant.  
 25 Now, if I'm wrong about that, please let me know.

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17:24 1 MR RAE: Yes.  
 2 MR MINEAR: I want to make sure that I understand that's  
 3 your theory.  
 4 MR RAE: So we calculate the amount of pondage; we then  
 5 double it. So they have a certain amount. And how they  
 6 want to use it, if they want to hold it on the  
 7 Saturday/Sunday, subject to the limits on paragraph 15  
 8 that constrain that they can't go below 50% on the  
 9 Chenab -- but anyway, subject to those limits, they can  
 10 reorganise it any way they want.  
 11 MR MINEAR: Yes.  
 12 MR RAE: And it doesn't have to be -- you know, India has  
 13 the flexibility. If, on a given day, they were able to  
 14 operate at firm power for three hours, and they decided,  
 15 "No, I don't want to do that; I want to operate at twice  
 16 the firm power for an hour and a half", they have the  
 17 flexibility to do that. It's not constrained.  
 18 But what is constrained is the original definition  
 19 of that volume. And once they've got that volume, the  
 20 operator can make use of it as a characteristic of the  
 21 plant.  
 22 MR MINEAR: Okay, thank you.  
 23 THE CHAIRMAN: So, Mr Rae, you were involved in both the  
 24 Baglihar proceeding and now in this proceeding, and it  
 25 does strike me that there is a reasonable amount of

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17:23 1 MR RAE: No, I think you're right about that. And this is  
 2 the point we've been making, is that if we go into  
 3 paragraph 8 of Annexure D, it gives us design criteria  
 4 and we're able to design a plant, but then the plant is  
 5 able to be operated however it's convenient to the  
 6 operator in India to do that. And its definition of how  
 7 it's operated is in paragraph 2; I forget which one,  
 8 I'm sorry. But there's a definition of "Pondage" which  
 9 says what its function is. But those don't inform how  
 10 it's calculated.  
 11 So we do the calculation first. We end up with  
 12 an amount. We end up doubling the amount that we  
 13 compute. And then that volume is made available to the  
 14 operator to use as they see fit, following the operating  
 15 rules in the Treaty.  
 16 I think -- is that in line with --  
 17 MR MINEAR: Yes, I just want to make sure I'm clear on your  
 18 theory; I'm not endorsing your theory. But your theory  
 19 doesn't need to consider a seven-day period for  
 20 calculating pondage. It's calculating pondage according  
 21 to a theory and a formula in the Treaty.  
 22 MR RAE: Yes.  
 23 MR MINEAR: And then there will be some operator who will  
 24 decide how to utilise that pondage in actually operating  
 25 a plant.

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17:26 1 difference between the approaches taken in the two  
 2 proceedings. The sort of qualitative side to it is  
 3 something we could talk about; the details we could talk  
 4 about.  
 5 But are you able to speak to the Court a little bit  
 6 about the differences that have now arisen that brings  
 7 Pakistan to where it is today with its methodology?  
 8 MR RAE: Over this methodology.  
 9 I would observe that my involvement with Baglihar  
 10 did not include the details of their pondage  
 11 calculation. So I was involved peripherally to it, and  
 12 predominantly involved in the spillway sediment intakes  
 13 and the like. But the one thing that has been common to  
 14 the Pakistan position is that the plant is to discharge  
 15 at firm power, and that's a very important commonality  
 16 between that time and now.  
 17 And when they went through the Baglihar process,  
 18 what you see presented certainly in the determination  
 19 and to some degree the documents submitted by Pakistan  
 20 after the first memorial were in some ways in response  
 21 to questions that the Neutral Expert was bringing up  
 22 through the process. And the process tended to take  
 23 a life of its own and say, "Well, they want us to answer  
 24 that question, so let's build it that way".  
 25 The underlying premise was still there, that it's

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17:28 1 for firm power; and the other premise of the Pakistan  
 2 approach is that we have firm power and we have pondage  
 3 in order to deal with the variability of the flow rate.  
 4 But it then got into a process of trying to determine  
 5 the number of hours per day of generation, and that  
 6 really wasn't part of the pondage calculation itself.  
 7 So I don't know if I'm helping with any of that  
 8 answer.  
 9 THE CHAIRMAN: No, that is helpful. I have one or two other  
 10 questions, unless you have any further observations.  
 11 MR RAE: No, go ahead.  
 12 THE CHAIRMAN: Okay. And feel free to push these questions  
 13 off to Dr Miles tomorrow if you wish to do so.  
 14 MR RAE: If he starts throwing things at me, I'll know!  
 15 THE CHAIRMAN: Well, let's hope it doesn't come to that!  
 16 You took us in your presentation to Annexure D,  
 17 paragraph 2(i), and walked us through the language that  
 18 appears there as to the term "Firm Power".  
 19 In my exchange with you, I noted that if one was  
 20 trying to work their way to a pondage calculation, it  
 21 seems like there's a lot easier way that we might be  
 22 able to do this of the kind that I mentioned, where you  
 23 just take the MMD, you bring those metric-cubed seconds  
 24 up to minutes, up to hours, you multiply the MMD by the  
 25 six hours that I think is your approach, and then we get

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17:31 1 very clear that it is a certain amount, it's a megawatt  
 2 rate, as opposed to being a volume of water. And if it  
 3 had been expressed as "minimum mean discharge" here, we  
 4 may have been discussing whether we meant minimum mean  
 5 discharge over five days or seven days or whatever. And  
 6 "power" to me adds more precision to the presentation  
 7 than I would have seen if perhaps it was in the rate of  
 8 minimum mean discharge.  
 9 THE CHAIRMAN: That is helpful. And again, feel free to  
 10 push off this question. But when I look at Annexure E,  
 11 which wasn't part of your presentation, I do see there  
 12 definitions, in Annexure E, paragraph 2. And there is  
 13 a definition at paragraph 2(h) on "Power Storage  
 14 Capacity" --  
 15 MR RAE: Yes.  
 16 THE CHAIRMAN: -- which then essentially points to a volume  
 17 of water. And I wonder if there's any implications one  
 18 should take from that comparison between Annexures D and  
 19 E in that respect.  
 20 MR RAE: Again -- well, from an engineering standpoint,  
 21 they're quite different things and the calculations are  
 22 done differently. What Annexure E is allowing is the  
 23 storage of water seasonally; and what they're defining  
 24 in here is a power pool which can be drawn from, as you  
 25 go through the seasons, to supplement the natural flow

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17:29 1 a number that we're going to double to get maximum  
 2 pondage.  
 3 MR RAE: Yes.  
 4 THE CHAIRMAN: If that is the correct process by which one  
 5 might determine pondage, it feels like that definition  
 6 in paragraph 2(i) could have been made more simple --  
 7 we might not even use the term "Firm Power" -- and yet  
 8 that's not what the Treaty drafters did. So  
 9 I'm wondering if you have reflections on that.  
 10 MR RAE: Well, now you're asking for conjecture, which is  
 11 always dangerous to get into.  
 12 But my own sense of it is that this is a document  
 13 put together which evolved over time. And having  
 14 started with the concept of power, they retained that in  
 15 the definitions, even though the actual extension to the  
 16 use of that in the pondage got supplanted by another  
 17 procedure that, as you point out, could have been just  
 18 written as "minimum mean discharge".  
 19 And I think there was an observation that at one  
 20 time, rather than to referring to this, it referred to  
 21 a power factor, which is another concept altogether.  
 22 But it also is just showing that there was an evolution  
 23 in the terminology, and at the point they finally  
 24 settled, they happened to settle on "Firm Power".  
 25 But for me the firm power is useful because it's

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17:33 1 of river, and that's what they call the "Power Storage".  
 2 So they draw from that over a period of months. And the  
 3 rate that they can withdraw from that constrains the use  
 4 of the storage, but the rate is basically capacity of  
 5 the power station.  
 6 So that has no direct connection back to Annexure D  
 7 because the computation and the purpose of the plant is  
 8 very different. Annexure E does refer to a "firm  
 9 power"; but again, it has the same meaning as the power  
 10 at the minimum. But it's calculated completely  
 11 differently, and it depends on the volume of the  
 12 reservoir and the operating policies for how that  
 13 reservoir is used, which are things that are not before  
 14 us at this moment to present.  
 15 THE CHAIRMAN: So that definition, if we can call it  
 16 a definition -- it's not really a definition -- but that  
 17 part of Annexure E at paragraph 21(a) which refers to  
 18 "firm power", that is -- as was, I think, mentioned last  
 19 week -- in your mind, that's referring to "firm power"  
 20 in its normal sense, as opposed to "Firm Power" in the  
 21 way it's being defined in Annexure D?  
 22 MR RAE: Yes, in its normal sense. And that's the point  
 23 where the reservoir is empty, for example, and it's at  
 24 its lowest level. Because when you drain a storage  
 25 reservoir, you drop down through several metres of

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17:34 1 elevation. And it's the power available at the bottom,  
 2 when you have only the natural flow rate available  
 3 because you've drawn all your storage out, and that's  
 4 the firm power there.  
 5 But you don't know how it can be calculated. It's  
 6 not related to something as simple as the minimum mean  
 7 discharge that we're able to use in Annexure D.  
 8 An Annexure D calculation is simplifying the  
 9 calculation. The Annexure E calculation requires  
 10 operating policy and operating rules for the reservoir  
 11 which derive these items.  
 12 THE CHAIRMAN: Would it be accurate, or semi-accurate, to  
 13 say that the way firm power is being approached in  
 14 Annexure E perhaps is similar to what India's position  
 15 is with respect to Annexure D; that is, it's focusing on  
 16 the plant more than it is on the MMD?  
 17 MR RAE: No. No. There's no relationship with the India  
 18 calculation and Annexure E.  
 19 The calculation that they make is -- the key  
 20 differences from what we're discussing here is they're  
 21 calculating with the installed capacity rather than firm  
 22 power. We say there's no foundation for that in the  
 23 Treaty, but that's the first key difference. And the  
 24 other key difference is they're taking the firm power  
 25 equivalent to a volume of energy. And again, we're

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17:37 1 Annexure E, is a seasonal variation; whereas under  
 2 Annexure D, it's a daily thing. We don't know which  
 3 day, but it's sometime within the dry season; or the  
 4 storage one tends to be, as a result of a long sequence  
 5 of low flows.  
 6 THE CHAIRMAN: Professor Buytaert.  
 7 PROFESSOR BUYTAERT: Thank you, Mr Rae. Just quickly  
 8 following up on that.  
 9 Assuming that the "firm power" in Annexure E is the  
 10 normal meaning, not given special meaning by the Treaty  
 11 because it's not capitalised, if you would apply, as  
 12 an engineer, that calculation of firm power, would you  
 13 use the load curve or any information about the loading  
 14 of the plant while doing so?  
 15 MR RAE: No. No. The only use of the load curve that's  
 16 been made is to look at the daily timing of the peaks.  
 17 And it's an observation that in the India calculation,  
 18 and also in the calculation that we make, there is no  
 19 parameter that we take from the load curve and enter it  
 20 into some equations to come up with the calculation.  
 21 The only use that's being made of it is to look at the  
 22 shape of the load curve and say: well, I need peaking  
 23 within these hours of the day.  
 24 PROFESSOR BUYTAERT: Yes, if you use the shape, then clearly  
 25 you use information related to the loading, isn't it?

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17:36 1 saying that's not consistent with the definitions such  
 2 as you see on the screen here.  
 3 What's going on in Annexure E has no relationship at  
 4 all to how they make that computation.  
 5 THE CHAIRMAN: You're not focused, in Annexure E, on  
 6 installed capacity of the plant as the basis for  
 7 identifying the firm power of the plant?  
 8 MR RAE: Annexure E would not use the installed capacity  
 9 either. The installed capacity will not be an outcome  
 10 of that firm power. I would have to look at the  
 11 specific wording. But it would be an extremely unusual  
 12 situation in the industry to have a firm power equal to  
 13 installed capacity for a large storage project.  
 14 THE CHAIRMAN: Any further questions?  
 15 MR RAE: And when I refer to a storage project, think of  
 16 Lake Mead. You have a situation where Lake Mead, the  
 17 level drops over a period of years. Now, India will  
 18 have no storage in the Indus of that volume. But as  
 19 that water level of the lake drops, the power capacity  
 20 of the plant drops as well. And at some point it gets  
 21 to its minimum storage level, where it can't generate  
 22 any more, and its firm power is at that level. That's  
 23 because as the water level drops down, it's reducing the  
 24 head parameter in the equation here.  
 25 But that, in the case of a storage reservoir under

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17:39 1 MR RAE: Well, the other point: if you think back to what  
 2 I said about the Indian power system last week, we're  
 3 looking at a power system in the northern region of  
 4 100,000 MW, and we're looking at plants here that are  
 5 less than 1% of that. So when you start looking at the  
 6 significance of those plants in their peaking, they're  
 7 almost insignificant compared to the total load  
 8 available. So that load curve actually has almost no  
 9 influence at all on any of the pondage calculations.  
 10 PROFESSOR BUYTAERT: You referred now to the cumulative load  
 11 curve. But you can also think about the daily variation  
 12 in loading, which obviously gives you information about  
 13 when the peaking happens and when an operator needs to  
 14 contribute to the peak.  
 15 MR RAE: Yes, I'm referring to the daily ones which  
 16 I displayed to you. I showed four for the year, typical  
 17 seasons. And in each of those, you're looking at  
 18 a baseload in the northern region which is over  
 19 100,000 MW. And for the all-India case, it's --  
 20 whatever the number is. Off the top of my head, it's  
 21 300,000 or 400,000 or something. And we're now talking  
 22 about power stations of 500-1,000 MW. The amount that  
 23 those vary during the day has next to no significance to  
 24 that load curve, and it's within the precision of that  
 25 estimate.

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17:40 1 PROFESSOR BUYTAERT: Okay, thank you.  
 2 MR RAE: It's a round-off error in the ...  
 3 THE CHAIRMAN: Just if I can be sure I understand what you  
 4 just said to Professor Buytaert.  
 5 The load curve is, generally speaking, not so  
 6 relevant in Annexure D. But it was a little less clear  
 7 to me: are you saying it's also not relevant with  
 8 respect to a storage work being used for hydroelectric  
 9 power in Annexure E?  
 10 MR RAE: Yes. And it's a bit what is shown on this excerpt  
 11 (slide 11). This is referring to the section on  
 12 run-of-river projects with pondage in the text, but it's  
 13 dependent on the minimum stream flow. And they refer in  
 14 this text to the "connected load curve". And the most  
 15 important influence of connected load curve here was to  
 16 make sure that a given power station, when you're adding  
 17 it to the power system, had enough capacity -- or,  
 18 sorry, that there was enough demand to be able to use  
 19 the capacity. And that check against the load to make  
 20 sure you can actually use it enters into the economic  
 21 analysis.  
 22 And I'm sure Dr Blackmore will remember back to the  
 23 World Commission on Dams. There was an interesting  
 24 section presented where they looked at the economic  
 25 viability of a lot of these projects and found that

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17:42 1 there simply wasn't demand when the projects entered,  
 2 and they spent years as under-utilised resources. And  
 3 that's the process that's being talked about here. And  
 4 that's the importance of load curve here, which was  
 5 probably more relevant 50 years ago than it is today.  
 6 THE CHAIRMAN: Okay. I'm still wondering then, in  
 7 Annexure E, when you're calculating maximum pondage and  
 8 it says, "it shall not exceed the Pondage required for  
 9 the firm power of the plant", what is the central  
 10 variable that one is grabbing a hold of in that context?  
 11 MR RAE: In Annexure E, it's referring to "Pondage", but  
 12 that's pondage within the overall storage.  
 13 So you've stored, say, 20 metres' depth of water.  
 14 And what the power system operator is allowed to do  
 15 within the shorter period of time -- I believe it refers  
 16 to a week -- is to have a certain amount of pondage  
 17 within that overall volume that they have to operate  
 18 within certain constraints. So they can't shut it down  
 19 to zero; they have to maintain some flow rate. But they  
 20 have the flexibility within that short period, as they  
 21 release water from the greater storage, to have that  
 22 fluctuate using the amount of pondage.  
 23 And we're getting into a lot of detail here, but  
 24 that's the purpose of pondage in that case. And again,  
 25 it's quite different from Annexure D, because it's

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17:44 1 a variability of a much greater storage that's being  
 2 utilised.  
 3 THE CHAIRMAN: Okay. Thank you very much for your  
 4 presentation. We've kept you a good 15 minutes past the  
 5 normal time, but that is clearly because we are quite  
 6 interested in what you had to say.  
 7 MR RAE: Okay.  
 8 THE CHAIRMAN: So thank you, Mr Rae, very much.  
 9 Sir Daniel, we did not get to Dr Morris today.  
 10 I take it he might be first up tomorrow, and then we  
 11 would proceed with the scheme that you presented to us  
 12 this morning. Is that correct?  
 13 SIR DANIEL: Mr Chairman, I think that that's right. It's  
 14 certainly right that we'll have Dr Morris first up. If  
 15 you are happy to do so, I think that we'd like to  
 16 reflect on the order and timing of the proceedings, and  
 17 maybe make a little bit of an adjustment in terms of  
 18 that. If you want us to come back, as it were, formally  
 19 to request the latitude to do so, we're happy to do so.  
 20 But if you are happy for me to go back into my MC role  
 21 tomorrow morning and just indicate how we'll proceed,  
 22 and the sequence and timing, that would be also helpful.  
 23 THE CHAIRMAN: Yes, I don't think there's any need to come  
 24 back to us with a request, but I think it would be  
 25 useful to receive something that indicates basically

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17:45 1 what the line-up will be for tomorrow, so that we can  
 2 see it in front of us and benefit from that.  
 3 SIR DANIEL: We will certainly do that before we come and  
 4 stand up.  
 5 THE CHAIRMAN: Very good, thank you.  
 6 In that case, I think we are done for the day. Many  
 7 thanks for the presentations. They were extremely  
 8 helpful, and I think showed a lot of hard work over the  
 9 weekend, so it's much appreciated. I hope you have some  
 10 respite this evening. But no doubt tomorrow we will  
 11 benefit greatly from whatever further work you do.  
 12 Thank you very much.  
 13 SIR DANIEL: Thank you.  
 14 (5.46 pm)  
 15 (The hearing adjourned until 9.30 am the following day)  
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