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

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

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

11 July 2024

Sean D. Murphy

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 4 Thursday, 11 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

BETWEEN:

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

Transcript produced by Trevor McGowan
Georgina Vaughn and Lisa Gulland

APPEARANCES

FOR THE ISLAMIC REPUBLIC OF PAKISTAN

MR SYED MUHAMMAD MEHAR ALI SHAH, Commissioner for Indus Waters, Ministry of Water Resources
MR ASAD KHAN BURKI, Legal Advisor, Ministry of Foreign Affairs
MR ZOHAIR WAHEED, Office of the Attorney General
H.E. MR SULJUK MUSTANSAR TARAR, Ambassador of Pakistan to the Kingdom of The Netherlands
MS FATIMA HAMDIA TANWEER, First Secretary, Embassy of Pakistan to the Kingdom of The Netherlands
MR JAMAL NASIR, First Secretary, Embassy of Pakistan to the Kingdom of The Netherlands
SIR DANIEL BETHLEHEM KC, Twenty Essex, London
PROFESSOR PHILIPPA WEBB, Twenty Essex, London
DR CAMERON MILES, 3 Verulam Buildings, London
PROFESSOR ATTILA TANZI, 3 Verulam Buildings, London
MR STEPHEN FIETTA KC, Fietta LLP, London
MS LAURA REES-EVANS, Fietta LLP, London
MR ABDULLAH TARIQ, Fietta LLP, London
MS MEGAN RIPPIN, Fietta LLP, London
DR GREGORY L MORRIS, Technical Advisor
MR PETER J RAE, Technical Advisor

THE REPUBLIC OF INDIA WAS NOT REPRESENTED

FOR THE PERMANENT COURT OF ARBITRATION

MR GARTH SCHOFIELD, Deputy Secretary General
MR BRYCE WILLIAMS, Legal Counsel
MR SEBASTIAN KING, Assistant Legal Counsel
MS VILMANTE BLINK, Senior Case Manager

Thursday, 11 July 2024

(9.30 am)

THE CHAIRMAN: Good morning, everyone. This is the fourth day of our hearing, and I see that Sir Daniel is at the podium. So I will give the floor over to him to get us started.

SIR DANIEL: Thank you very much, Mr Chairman, members of the Court. Good morning. I hear rumours that there was a football match yesterday, but some of us didn't have an opportunity to glance at it. There we are.

(9.31 am)

Submissions on Construing the Design Criteria of Paragraph 8 of the Treaty

SIR DANIEL: Against the background of our building-block submissions over the past days, we are turning today, Mr Chairman, members of the Court, to address Pakistan's detailed case on the interpretation of the paragraph 8 design criteria.

As you know from our scheme of submissions, we will do this through a number of submissions, starting with Dr Morris, followed by a cascade of submissions by Professor Webb and Dr Miles, who, until this point, has had to sit quietly and patiently waiting for his moment to come. But it will come: he will be on his feet three times over the course of the next two days.

09:31 I will start us off this morning with something a little bit more substantive than my MC role over the past two days, addressing the topic of construing the design criteria of paragraph 8 of the Treaty. My purpose is to draw together some of the points that we've addressed over the past three days that will be relevant to the analysis to come.

I expect that I'll be on my feet for about 30 minutes or so. And depending on the timing of the rest of the day, I expect to be back at the end of the day to make some brief submissions about the calculation of pondage, which are intended to be a bridge to Dr Miles's submissions tomorrow, who will do the heavy lifting on the topic.

So I start with three broad points, to frame the issues.

First, the dispute of which you are seised is a dispute about two issues: the sediment management of and the storage of water by Indian run-of-river HEPs on the Western Rivers. The question in respect of both is: what is the scope and the content of the constraints imposed by paragraph 8 of the Treaty on India's latitude, first of all, to manage the accumulation of sediment in its Western Rivers; and second, to store water?

09:33 Integral to this is the issue that the constraints in question are design constraints that must be written into the HEP before it is constructed. This is the only way to safeguard Pakistan's right of unrestricted use of the waters of the Western Rivers, as the Treaty does not contain an effective mechanism for the operational oversight of a HEP once it is constructed.

So if a permissive approach is adopted to the design of a plant, for purposes of allowing for operational flexibility in due course on the basis of India's unilateral appreciation, Pakistan would have little real remedy or recourse. Even if the Treaty does contain important operational limitations -- for example, in paragraph 15 of Annexure D -- it has no effective real-time compliance and enforcement mechanisms that apply to India's operation of its Western River HEPs. Critically, therefore, Pakistan's Treaty rights can only be meaningfully safeguarded at the design stage, before the HEP is built.

And the Treaty recognises this, as it is at the design stage that the constraints on India's conduct fall to be imposed. So the chapeau of paragraph 8, which I took you to the other day and with which you'll be very familiar, is cast in terms of mandatory design criteria:

09:34 "... the design of any new Run-of-River Plant ... shall conform to the following criteria: ..."

That's the chapeau of paragraph 8.

Mr Chairman, members of the Court, this appreciation is important, and it will be important to the Court's task, as it means that if they are to be useful, the interpretations that the Court will reach on the various subparagraphs of paragraph 8 will need to be precise and certain; insofar, of course, that you will conclude that you can be precise and certain. Interpretations that say, for example, "it depends", are likely to be less than helpful, as there are unlikely to be effective avenues to resolve the disputes that will almost certainly follow from anything that is less than precise and certain. It is essential that the interpretations arrived at by the Court provide workable and effective clarity for the parties on the meaning of these contested terms.

My second framing point is that, within margins, largely to cater for the site of its proposed HEPs, India, for the past 32 years, has been presenting Pakistan with one largely standard design for its HEPs. Since Baglihar in 1992, the parties have thus been stuck in a loop of proposal and objection, followed by standoff.

09:36 Amongst many others, there are two important reasons for this impasse. The first is that India is designing for its 5,000-plus large dams countrywide, not for its 201 Western Rivers HEPs. The second is that, seemingly with a view to frustrating meaningful engagement on its designs, India has been and is being less than forthcoming in its compliance with the exchange of information obligations under the Treaty, whether this is under paragraph 9 of Annexure D or under Article VII, paragraph (2) of the Treaty.

As you will recall, the language used by Pakistan's Commissioner in his testimony to you on Monday was that Pakistan is being presented successively with fait accompli. And as you heard from Dr Morris, India appears not to be designing its plants with a view to taking into account downstream effects. This is a significant problem and one that, once again, calls for a precise and clear articulation of the meaning of the mandatory design criteria in paragraph 8.

Mr Chairman, members of the Court, with an eye to the principle of effectiveness of treaties, you may indeed consider that you can also say something in due course about the cooperation and information-sharing obligations under the Treaty, insofar as they are linked to the effectiveness of the paragraph 8 criteria.

09:38 My third framing observation comes to a point made repeatedly by Dr Morris, and one to which I will also return more than once, and I suspect he will return to again once I've concluded, and it is that India has a choice of sites, a choice of where to locate its HEPs. And as Dr Morris put it, design engineers are not presented with a river: they are presented with a site.

India evidently considers that it is free to choose where it wishes to locate its HEPs. Viewed with a long lens, this is certainly true. It is not for Pakistan to tell India where it can or should build its HEPs. But what you see through a telescope you see rather differently through a microscope, and close review paints a more complex picture.

The Treaty, a cornerstone legal instrument governing relations between the parties, imposes obligations on both parties which intrude into their decision-making space. Pakistan cannot dam up the waters of the Eastern Rivers, or otherwise interfere with the flow of the waters of the Eastern Rivers, before they finally cross into Pakistan. Similarly, India is under an obligation to let flow the waters of the Western Rivers, and to exercise the exceptions that avail it in respect of the non-consumptive use of those waters, in a manner that will not impede Pakistan's right of unrestricted use.

09:40 So these provisions intrude into the decision-making space of each state.

Within this framework, India's choice of site for its HEPs will, or at the very least may, be highly material to its ability to comply with its obligations under the Treaty.

If, for example, India chooses to design a high dam in a wide gorge with significant dead storage, all for purposes of raising the operating pool to an elevation that will generate sizeable head, there is every chance that the size of the reservoir will give rise to issues of Treaty compliance with regard both to pondage and to sediment management. As Dr Morris explained yesterday, in such a case, every metre in height of the dam wall will impound an enormous volume of water in the reservoir. It is the inch-thick, mile-wide calculation.

In contrast, India could choose to locate the dam of a HEP upstream, on the basis that the head otherwise planned to be achieved by constructing a large dam would be achieved through a longer headrace tunnel, with the result that there would be no need to raise the height of the operating pool. This may comply more readily with the Treaty's requirements for pondage, as well as other design elements, and would be more conducive to the sound management of sediment.

09:41 I will come in a moment, when I pick up some of the threads from Dr Morris's presentation, to give you a reference to the Kishenganga partial award where the Court, in those proceedings, in fact recognised precisely this issue.

India has a choice of where to locate its HEPs. When doing so, however, it must have regard to its international obligations to Pakistan under the Treaty. Its choice of site will facilitate or it will hinder or it will frustrate India's ability to comply with its Treaty obligations. This may also give rise to higher or lower costs of compliance with the requirements of the Treaty. India's choice of site and costs of compliance to its mandatory Treaty obligations must, however, hew to the Treaty, not the other way round.

As you again heard from Dr Morris yesterday, at a reasonable site, there will always be effective Treaty-compliant means of sediment management. India's choice of site will be critical to the design choices that it will be required to make, if it is to meet its Treaty obligations. It cannot treat the choices of site as falling outside the framework of the Treaty. The interpretation and application of the mandatory design criteria of paragraph 8 must take account of this, and cannot proceed on the basis that the paragraph 8 criteria only become engaged once India has chosen its preferred site.

Mr Chairman, members of the Court, I turn from these framing points to recap a number of points about the scheme of Article III and of Annexure D, and paragraph 8 thereof, that will be relevant to your interpretative task. And we've addressed these already, so I'm just pulling out a number of summary points.

First, to the point of the rule and its exceptions, whatever may be the doctrinal debate between Humphrey Waldock and Gerald Fitzmaurice, as two of the International Law Commission special rapporteurs, the controlling consideration is the structure of Article III, and the way that the rule and the exception is expressed. And we say that in our case this leaves no room for debate at all. The Waldock/Fitzmaurice debate is a doctrinal debate that is taking place somewhere at the far corner of the garden; it's not in this room.

The provisions on which we are focused are not structured as two detached clauses that might be interpreted in isolation from or independent of each other. The rule is stated: Pakistan shall receive the unrestricted use of the waters, and India is under an obligation to let flow. The rule is then elaborated

09:44 upon: India shall not interfere with the waters and shall not store any waters. And then the hydropower exception is enumerated: except for the generation of hydroelectric power and associated storage, as provided for in Annexure D for these purposes.

These three elements -- the statement of the rule, the elaboration of the rule and the statement of the exception -- are all addressed in a single article, in Article III. And the structure of the article leaves no doubt whatsoever about the superior and subordinate relationship of these provisions.

It is also material that the hydropower exception, while expressed in Article III, is only elaborated in Annexure D. Annexure D, however, is not a self-standing provision, as its subheading and paragraph 1 make abundantly clear: it is subordinate to Article III. Annexure D cannot, therefore, be construed without reference or regard to Article III. The language of Article III(2) and III(4) also are expressly drafted in terms of a principal, affirmative statement of Pakistan's right or entitlement, followed by a carve-out for the exception for India's hydropower generation.

Mr Chairman, members of the Court, the structure and the terms of Article III and Annexure D do not, we say, do not admit of any other reading than that they state,

09:46 by way of a principal and superior clause, Pakistan's right to unrestricted use, and, by way of a subordinate clause, India's entitlement, by way of exception, to generate hydroelectric power.

In our submission, it follows that on the basis of settled canons of treaty interpretation, which you heard about from Professor Webb, the exception falls to be construed narrowly. In other words, it falls to be construed in a manner that does not diminish the primary rights of Pakistan, unnecessarily so; or it falls to be construed in a manner that is as least intrusive as possible into Pakistan's right.

Turning to the scheme of Annexure D. I took you through its structure on Monday. Let me recap briefly some of those elements in headline terms.

Firstly, we have the definitions in paragraph 2, key elements of which were given special meanings. And let me just pause for a moment to emphasise this point about special meanings.

You heard Professor Webb on the issue of special meanings under the general rule of treaty interpretation in Article 31, paragraph 4. If a special meaning is intended, that special meaning must be accorded when it comes to the interpretation of the Treaty.

And as Professor Webb has addressed, as I addressed,

09:48 and as both Professor Webb and Dr Miles will come on to address in due course -- I should say, as also Mr Rae has addressed -- there are a number of critical provisions in the Treaty in Annexure D which are accorded special meanings, meanings that are different from the meaning that is attributed to them in normal engineering parlance. "Pondage" is one, "Firm Power" is another, and there are others as well.

So we've got paragraph 2, which provides a number of definitions, and accords special meaning to a number of key provisions. Paragraph 8 then sets out the mandatory design criteria. We then have in paragraphs 9 to 11 the information-sharing, objection and dispute settlement provisions; and then finally, the provisions addressing the operation of the plant set out in paragraph 15.

We will come to all of those in these submissions over the course of the next two days. There are, of course, other relevant provisions, which we will cite as appropriate, but these are the key ones for present purposes.

Leaving aside subparagraph (g) of paragraph 8, which is not present for present purposes, each of the other subparagraphs essentially address two issues: first, constraints on the storage of water; second, constraints on the design of the plant for purposes of sediment

09:49 management.

Subparagraphs (a), (b) and (c) address design criteria relevant to the storage of water: (a) the dam shall not be capable of artificially raising the level of the water; (b) the importance of taking into account the requirements of surcharge storage and secondary power; and (c) the calculation of maximum allowable pondage.

Subparagraphs (d), (e) and (f) then set out design criteria that essentially impose design constraints that address the management of sediment. They are, of course, not expressly cast in these terms or exclusively focused on sediment management, but it is evident that this is their primary purpose. And this much is clear from the terms of subparagraph (d), which, as Professor Webb will shortly address, is the controlling provision in this cascade of provisions.

Addressing outlets -- all outlets -- subparagraph (d) says that:

"There shall be no outlets below ... Dead Storage Level, unless necessary for sediment control or any other technical purpose ..."

As well as the express reference here to "sediment control", the absence of any reference to what is meant by "other technical purpose" is a strong indicator that

09:51 the principal focus of this provision is sediment management. And as I've just said, and as Professor Webb will elaborate upon, paragraph (d) is the gateway through which you then get to paragraphs (e) and (f) as well.

As will become clear from the submissions by Professor Webb and Dr Miles, each of these provisions of paragraph 8 are designed to work together. They each address a different aspect of the design of a run-of-river HEP. They are not independent provisions that operate in isolation of one another. Taken together, as must be done, they disclose an unambiguous intent on the part of the drafters of the Treaty, agreed to by the parties, to impose tight constraints on India's design latitude in respect of new run-of-river plants.

These constraints need to be construed to achieve the effect for which they were intended, both individually and collectively: namely, to confine, by design, India's ability to store water and to manipulate the use of that stored water in a manner that would or could undermine Pakistan's right of unrestricted use of the waters of the Western Rivers.

So let me then come to some takeaway points of legal interpretation from the last few days, to draw some

09:52 threads together which are relevant to the task of construing paragraph 8. And I will just pick up a number of headline points from one or two of the submissions. By this I don't mean to undermine the richness of the submissions elsewhere. The submissions that you've heard up until now, setting the very broad base of the pyramid, will be a rich vein to be mined for interpretative purposes. But I just want to shine a light on a number of them.

I start with two from Ms Rees-Evans's review of the circumstances of conclusion of the Treaty and its travaux préparatoires.

The first is that since 1948, Pakistan has lived in the shadow of water weaponisation: that India, its powerful upper riparian neighbour, has the ability to cut off or manipulate its supply of water at will. It was Pakistan's appreciation of the risk of weaponisation that drove its negotiating position on the Treaty in favour of water independence; in other words, Pakistan's right of unrestricted use. This was a constant theme in the negotiations, which ultimately found expression in India's let-flow, non-interference and no-storage obligation in the final text of the Treaty.

And then second, while India attempted to cut back Pakistan's position, and was indeed able to secure

09:54 various exceptions to Pakistan's right of unrestricted use, notably for the generation of hydroelectric power, this exception was tightly constrained.

I follow these points from Ms Rees-Evans's submissions with three principles or propositions drawn from Professor Webb's submissions that can be very briefly stated. I anticipate you have these well already.

First, paragraph 8 must be construed in the wider context of the three bargains at the heart of the Treaty: the peace bargain, the Treaty bargain and the hydro bargain.

Second, being an exception to the primary rule, paragraph 8 must be read subject to the primary rule of unrestricted use, let flow, non-interference and no storage in Article III(1), III(2) and III(4), and must be construed narrowly.

Third, the Treaty not only does not exclude best engineering practices, but it positively requires that India adopt such practices in the service of the Treaty.

Mr Chairman, members of the Court, there are other principles and propositions to be drawn from our legal submissions these past days that will be relevant to your task of construing paragraph 8, but these are the ones that are key that I shine a light on just for the

09:55 moment.

I turn then -- and I will conclude with this -- but I turn then to a number of takeaway engineering points from the submissions by Dr Morris and Mr Rae.

Starting with Dr Morris, I note six headline points under which will be captured a wider array of salient engineering insights that will inform your interpretative task.

First, the issue writ large arising from the interpretation and application of paragraph 8 is one of risk and damage to Pakistan that would flow from a permissive interpretation of the paragraph 8 provisions. For India, there will always be a workaround. This is not the case for Pakistan.

Second from Dr Morris, sediment is the primary issue of challenge and concern for run-of-river HEPs in the Himalaya. Sediment will be the primary factor that will control design.

Third, where to locate a HEP is a discretionary choice for India. Where India chooses to site its HEPs will be a critical factor in its ease of compliance with the paragraph 8 design criteria.

Fourth -- and this is perhaps the biggest, as it were, in volume terms, takeaway from Dr Morris's submissions -- fourth, there are a wide range of

effective sediment management techniques that would be available to India to address issues of sediment management. Apart from drawdown or empty flushing, these include: sluicing, the use of desanders, dredging, resort to sediment-guided operations, turbine coating and the use of off-site reservoirs. Sediment management should be treated as an issue of operational cost when it comes to run-of-river HEPs, for example, with respect to the coating of turbines.

Fifth from Dr Morris, if the choice of site is reasonable, there will always be effective workarounds to address sediment management and workable alternatives to flushing. There is nothing inherently overwhelming about the design constraints of the Treaty. There is not a one-size-fits-all approach.

And in this regard, also drawing the link to my submissions a moment ago, I draw attention to the analysis and conclusions of the Kishenganga Court at paragraph 521 of its partial award, which expressly considered and addressed the issue of the size and location of a HEP when it came to the issue of dam design for purposes of effective sediment management. That's paragraph 521.

And then finally from Dr Morris, there are very significant downstream problems associated with

09:59 drawdown, or empty, flushing, not least of all environmentally. It is not unusual to have restrictions or even prohibitions on flushing; in contrast to sluicing, which, as Dr Morris explained, tries to "mimic the natural pattern" of the river (Day 3, page 44, line 21). And one example that he gave of the contrasting regulatory approaches to flushing and sluicing is found in the 2005 US Army Corps of Engineers regulatory guidance letter, which is at Exhibit P-612.

Now Dr Morris was on his feet for about two and a half hours. I think that there is a richness in his submissions -- and he will pick up on some of these themes shortly -- a richness in his submissions for purposes of the interpretation of paragraph 8 from an engineering perspective. Of course, the controlling text is a legal text, which is why we are presenting it in this form. But I would very much invite the members of the Court to go back over Dr Morris's submissions, both the ones given and no doubt the ones to come as well.

From these takeaways from Dr Morris, I would add three from Mr Rae's submissions.

First of all, run-of-river HEPs operate on the basis of storage on a day-to-day basis: they are intended as daily peaking plants.

10:00 Second, there is a good deal of uncertainty and variability in load curves. These change over time with changing demand, with changes in a country's level of development and other factors. And these are observations that Mr Rae made in response, Mr Minear, to questions that you posed.

And third from Mr Rae, and this is a point that I will come back to later this afternoon: the Treaty adopts bespoke definitions, special meanings, for -- in particular for these purposes -- "Pondage" and "Firm Power".

The definition of "Firm Power" in the Treaty is, in Mr Rae's words (Day 3, page 75, lines 2-8):

"... a ... formula that simplifies [the] computation of ... firm power by establishing the flow rate that will be used to calculate firm power. And this simplification allows for the definition of firm power without resorting to ... assumptions."

Mr Chairman, members of the Court, I am at the end of my submissions. Both Dr Morris and Mr Rae's submissions provide, again, rich veins of expert engineering insight, from which a range of other principles and propositions may be drawn to inform your interpretative exercise. The points that I have just now drawn out will inform the submissions that you will hear shortly from Professor Webb and from Dr Miles: Professor Webb addressing outlets, spillways and power intakes; that is, the interpretation of subparagraphs (d), (e) and (f) of paragraph 8. Dr Miles will follow Professor Webb this afternoon, addressing the issue of freeboard; that is, the interpretation of subparagraph (a) of paragraph 8. And Dr Miles will return tomorrow for a lengthy period to address pondage and the interpretation of subparagraph (c) of paragraph 8. But before any of that, we have the benefit once again of Dr Morris's further submissions on the subject of approaching paragraph 8 from the perspective of an engineer.

Without more ado, Mr Chairman, unless there is anything with which I can help you or other members of the Court, may I ask you to invite Dr Morris to take the podium.

THE CHAIRMAN: Thank you, Sir Daniel. I don't have any questions relating to what you just said. But I've been reflecting a little bit on the presentations from yesterday, so I thought I would offer up just a few comments/questions that you don't need to take on right now, but it may help you with respect to presentations to come, and possibly second round as well.

(10.03 am)

10:03 Questions from THE COURT

THE CHAIRMAN: The first is that Mr Fietta yesterday presented to us on the issues concerning precedential effects of Court of Arbitration decisions and Neutral Expert determinations. Those issues, as we know, fall under paragraph 35(a) of Procedural Order No. 6, and they seem to be questions that are somewhat different in nature from the other questions that we are also looking at from the remainder of paragraph 35.

As one ponders ultimately deciding on these questions, one possibility is to decide them all together, in a single award. The other possibility would be to take those particular questions and separate them out for a separate award.

I raise this in part because one might imagine that that separate award on paragraph 35(a) might be capable of being issued on a sooner rather than later timeframe, whereas the other questions before us have a certain depth and complexity to them that perhaps will take a bit longer.

In either instance, I will emphasise, the Court is going to taking the time it needs to do its work in properly assessing and deciding the questions. But there may be advantages in keeping these all together, in a single, relatively comprehensive systemic questions

10:05 award. There may be some utility in breaking them out, if having an award related just to paragraph 35(a) on a sooner-rather-than-later timeframe was helpful to the parties for whatever reason.

So I just wanted you to think about that. I know tomorrow you'll be talking to us a bit about what the dispositif might look like, what the reparation you seek looks like, and perhaps in that context you'd want to provide us any reflections on that.

Completely separate from that, I think it was during Professor Webb's presentation, we had some interest in the relationship of Annexure D to Annexure E. And I realise that Annexure E is not before the Court in this particular proceeding.

Having said that, it does seem that to the extent that Pakistan believes that a let-flow, non-interference, no-storage principle should help guide us and inform us in our interpretation of Annexure D, then perhaps we should have some eye on Annexure E, which seems to allow for a fair amount of storage of water, and therefore arguably works a little bit against the idea of "let flow", or at least we don't quite understand how it relates to that Annexure E.

I suppose I'm also curious about: the volume of storage that Pakistan is worried about in the context of

10:07 Annexure D, how does that relate to the volume of storage that is allowed under Annexure E? To the extent that it's a small percentage in Annexure D of Annexure E, then one wonders why there would be a lot of emphasis on Annexure D as opposed to Annexure E. Perhaps they're the same amount of volume. We just don't know, because you haven't really spoken to us on that issue.

The use of the storage in Annexure E also isn't entirely clear to us. How readily India can release from the storage units and then fill them back up seems as though it may be relevant to this issue of the "let flow" and the concern that Pakistan has.

One way of approaching talking about that could be: what were the problems with KHEP, in the context of being a storage facility as opposed to a hydroelectric plant? We don't know, I don't know if that provides any insights.

But again, I don't expect you to answer this; it's not actually the subject we're talking about today. But because it came up yesterday and because it's on my mind, I thought I would at least offer it up to you as things to be thinking about in the days to come.

SIR DANIEL: Thank you very much, Mr Chairman. Let me just make a brief response on the second of your points, and

10:09 perhaps a slightly fuller but still brief response on the first of your points.

Certainly we will come back on the question of Annexure E, and the relationship between Annexure D and Annexure E. I think that we will do so in the second round next week, because I think that some of the issues that you've put on our plate are quite big issues that we'll want to try and unpack, rather than trying to feed them into the submissions that we're making at the moment.

As you say, there's going to be a little bit of history here which we can try and unpack, in particular with regard to Kishenganga, going back to 1988 and its evolution from the proposal that was originally in Annexure E, storage plants, to which we objected, and then it metamorphosed into an Annexure D plant. So we will have a look at that.

There are, in fact, some very real and pressing issues which are not now before you, but we'll have to give careful thought just to how they may play into this. For example, on the Chenab -- as Dr Morris was talking about -- in fact, upstream of a number of the run-of-rivers -- of Baglihar, Ratle, Dul Hasti -- you've got the construction of a very, very large storage dam, Pakal Dul, and there are questions associated with that

10:10 for the downstream. Pakal Dul, for example, is likely to act as a sediment trap for some of the smaller downstream plants.

But let us give some thought to the interaction between E and D, and we'll come back to that.

You've enumerated -- I've made a note here -- I think three elements in relation to Annexure E that you have in mind from our submissions to this point. But if there are any particular points that you would like to draw to our attention, including in the questions that you will put to us on Saturday, that would certainly help to focus our minds on addressing your concerns.

On the question of whether there may be advantage to a single award which encapsulates all of the paragraph 35 questions, or some advantage in having a partial award much more quickly, focused on 35(a), and then coming back to the other issues later, I am going to address you a little bit on this tomorrow, and we will come back to this, obviously, in our closing submissions in the light of the exchanges tomorrow.

There would certainly, instinctively, be some advantage in clearing away, to useful effect, the, if you like, precedential weight of decisions of the Kishenganga Court, the Baglihar Neutral Expert, indeed

10:12 of your Court as it's to come, particularly because this is likely to have helpful implications for unpacking a little bit your duty of comity that you've set out in paragraph 6. So that is immediately attractive at one level.

There is, though, a question that comes to our minds, which we will think further on, but I'm not sure ultimately that this is something that will be in our control to calibrate, but it most certainly would be within your control to calibrate. And that is that if you give a partial or preliminary award on the interpretation of paragraph 35(a) issues, and those open up issues of substance which need to be revisited with regard to the 35(b) through to (g) issues, there may very well be a question as to whether you want then to have further submissions from us as to how the partial or preliminary award that you render on -- if I can, by shorthand, use it -- "the res judicata point", whether that has any implications for the arguments that we've been making on the other issues.

So you will be able to calibrate that as you go along, because if you come to a conclusion on paragraph 35(a), you will have, I imagine, a pretty good sense of whether this will have knock-on implications or not.

10:13 I imagine, though, that it will be very helpful, certainly for us, maybe also to clear away some of the underbrush in your thinking; and undoubtedly, I expect, for the Neutral Expert to have some guidance on this. Because he is quite clear, on the public record of his proceedings which are before you, that he is not a lawyer and he's not going to be turning to questions of legal interpretation. And it is quite clear from paragraph 1 of Annexure F that his remit is limited, as an engineer, to those technical engineering points. So there would be, possibly, some very useful effect of that.

Just one last observation, and this is an observation that I was going to make in any event tomorrow. You said quite clearly and quite forcefully, laying down a marker for us, that you are going to be taking the time that you need to get this right. In fact, I was going to stand up here tomorrow and say that we very much appreciated the expedition with which you rendered your Competence Award last year, but we very much appreciate that these are very complex issues on the basis of very detailed submissions, and your award is going to be an award for all time.

So we do not want to rush you on this. You are not going to be coming under pressure from us for you to

10:15 render an award in whatever time. We want you to take the time that you feel that you need to render an award which properly covers the ground and allows you a proper opportunity to deliberate and to draft.

So that's also part of the wider context of the 35(a) separate issue, which we will think about and I'll return on.

THE CHAIRMAN: Two other elements to factor into that last point. One is that under our Supplemental Rules of Procedure, it does say that "The Court shall endeavor to [issue an] Award within 6 months" after a hearing. Of course, the word "endeavor" means it may or may not happen on that timeframe.

But the second element worth recalling is that we have called upon Pakistan to produce certain documents. Those documents are due no later than September 30. This means there will be some post-hearing events happening. In all likelihood, those documents are pertinent to questions other than 35(a), and therefore wouldn't necessarily affect the decision that could be reached regarding 35(a) issues.

But given that there will be at least those post-hearing developments, it may well be that the typical six months is not just six months from the hearing, but from perhaps our ability to have a complete

10:16 record in front of us.

SIR DANIEL: Once again, Mr Chairman, we will obviously wish and want and hope to receive your award as soon as you can render it, but you are not going to come under pressure from us. And the "[will] endeavor" I think is an appropriately phrased but sufficiently flexible standard.

I note that from the date of your Competence Award, or the date of your directions, if I recall, in PO7, it took us, I think, eight months to produce our Memorial, and we've been thinking about these issues for some time. I don't think that we are going to want to hold you to a standard which we felt we were unable to meet.

We would like you to get it right, because this is going to be the roots of the next 64 years of the Treaty. So we don't want something that you are not going to be content with because you don't have sufficient time.

THE CHAIRMAN: Very good, thank you.

In that case, I think we are ready to move on. And if I understand correctly, it's Dr Morris who will be coming to the podium.

SIR DANIEL: It is indeed. (Pause)

Perhaps while Dr Morris is just gathering his things, I'll say that we've been planning on the basis

10:18 that Dr Morris would be up at the podium for about an hour and a half, which will mean that he will straddle the coffee break. But although we are a little bit more stressed for time than we have been over the course of the early part of the week, I think that we still do have a little bit of wriggle room. So, again, these are very important submissions, and we would invite the Court to raise the questions that you feel you need to raise.

THE CHAIRMAN: Very good. Thank you, Sir Daniel.

Bearing that in mind, as we approach the normal time for a coffee break at 11.00, perhaps I will see if Dr Morris is thinking that there's a good place for a break. But we can discuss that when we get to that point.

So, Dr Morris, please proceed whenever you are ready. (Pause)

(10.19 am)

Approaching Paragraph 8 from the Perspective of an Engineer

DR MORRIS: Good morning, gentlemen. It's a pleasure to address the Court one more time.

(Slide 2) Today I would like to talk about paragraph 8 in Annexure D, which covers the run-of-river hydro. We will be covering it from the standpoint not of a lawyer, but the standpoint of an engineer who would

have to deal with these types of restrictions in the design of a plant, design and operation.

So basically there are seven design parameters. And when looking at a plant, we look at physical factors, social factors, financial factors. But they need to be, for a Treaty-compliant plant, developed within the context of what the Treaty says.

(Slide 3) The first thing the Treaty says is that works "shall not be capable of raising artificially the water level": not to raise it above the full pondage level that's specified in the design.

Now, you can structurally modify dams to increase the water level. Typically, it's not done very frequently because it's costly, you increase upstream flooding. But it can be done. And some dams in fact are designed to eventually have higher gates, et cetera.

But the key concept here is that the operator should "not be capable". In other words, I understand the capability here is that you can't easily do this, short of structural modification.

This is one reason why it's also important to limit the freeboard, because the more freeboard, the more potential space you have to increase the water level.

And it's quite important because -- we looked yesterday at the elevation capacity curve, and we saw

10:22 that on this curve we can see the area of the red dotted line on slide 4. And if you raise above the full pondage level, every increment, every metre of increased elevation, gives you a lot more storage capacity. So it's very important to limit the ability to conditionally raise the level.

(Slide 5) And you will remember from the prior discussion that if you have a crest spillway, the ability to raise the level is limited by overflow over the spillway crest. But if you have an orifice spillway, and you do not have a crest associated with it, then the operator can simply operate the gates to raise the water level.

So the conclusion as a designer from this particular parameter is: if I am going to provide an orifice spillway, I also have to have a surface spillway. I have to have both. I can't just do an orifice spillway, because that would allow the operator to simply utilise the freeboard as additional storage. That's pretty straightforward.

(Slide 6) 8(b), surcharge and secondary power:

"The design of the works shall take due account of the requirements of Surcharge Storage and ... Secondary Power."

Now, the Treaty defines, in paragraph 2(e), the

10:23 "Surcharge Storage" as being the "uncontrollable storage ... space above the Full Pondage Level"; in other words, uncontrollable, like we saw on the prior slide, because it would overtop the gates if you were to use the storage volume. Of course, during a flood, the gates would be open and this area fills with floodwaters; and as the flood recedes, the level goes down. So it's not controllable storage.

And again, I see this as pretty straightforward. It just says that you are allowed to use flood surcharge storage, which is absolutely perfectly normal. Some of the plants that India has done do not include surcharge storage; others do. There's nothing unusual about that at all.

And it also says that they will take in the requirements of secondary power. And the way I read that is basically to ensure that India can in fact build the capacity of a plant as they want. It doesn't mean the capacity of pondage, but the generating capacity. So the Treaty goes into the definition of "Firm Power". And the language here, the way I read it, is to ensure that the Treaty is not misread to say that India's installed power is limited to the "Firm Power" that's defined in the Treaty.

So it's basically a protection of India's ability to

10:25 put as much generating capacity as they want on the plant, because the generating capacity is not related to the storage volume, and it's also not related to -- remember, you have a certain amount of water you can release downstream on a daily rate: you have a maximum and a minimum. So within those parameters, they can put whatever generating capacity they want.

(Slide 7) Pondage. This is where it starts to get interesting.

"The maximum Pondage in the Operating Pool shall not exceed twice the Pondage required for Firm Power."

And "Pondage" is defined elsewhere, and someone else will talk about -- I think Dr Miles will talk about pondage a lot.

But the Treaty defines the allowable pondage based on firm power, which in turn is directly related to the hydrology of the site. It's not the design capacity of the turbine. In normal operation, you'd say: I have this much plant capacity, I want to be able to operate it, let's say, four or six hours a day, so given my plant capacity, given my operational hours for peaking, this gives me the pondage.

It doesn't work that way here. The pondage comes from the hydrology. And this is entirely appropriate because the Treaty is set up to protect Pakistan's

10:27 hydrology. So therefore, if you're going to protect the hydrology, the pondage is defined in terms of hydrology.

It's also interesting because you're going to design a dam, or look at a river system and put dams on it. Dams control water. And your starting point, the very first thing you have to have, information on that site, is the flow. If you do not know the flow rate in the river, you cannot do anything with respect to design of dams; nothing.

So your starting point for design process is flow. And from the flow, you get pondage. So basically, under a Treaty-compliant reservoir, the first parameter, the first design parameter that is defined is pondage. And that's a little bit different from most design processes. But because the objective of the Treaty is to protect hydrology, it completely makes sense.

(Slide 8) Now, the Treaty also limits drawdown to the bottom of the pondage pool. In other words, you have the operating pool, pondage: that has a full pondage level and it has a dead storage level. So that operating pool is the region within which you can operate the plant for power production and also operate the plant for sediment management.

Now, in the Himalaya we have a pretty high sediment load. So you're thinking about: I need to have some

10:29 variation in my water level for sediment management, in addition to pondage. And we've done a couple of diagrams on that in the last couple of days.

Flushing also requires drawdown, but it requires emptying below the dead storage level so it's not Treaty-compliant. So I will not discuss flushing here, within the context of this particular item.

So assuming that you have a Treaty-compliant design, your drawdown for sediment management is limited to the depth of your operating pool.

(Slide 9) Now, remember the graph we showed a couple of slides ago of the elevation capacity curve. This is the curve for Baglihar. This is taken from data that India provided under the Baglihar proceeding.

And as shown in the generic graph, you see that as you go to larger volumes of storage here -- at the bottom you see 400 million cubic metres, which is the total volume of storage of the reservoir. And if I'm at the top of the reservoir -- this is 127 metres deep; this is 127 metres deep from the original riverbed to the top of the full reservoir level: it's the water depth. And if I'm using 32.5 million cubic metres of pondage, which was defined by Professor Lafitte, I can accommodate 32.5 million cubic metres in the top 4 metres of that reservoir. I can only draw down my

10:30 reservoir by 4 metres.

If that dam is a smaller dam -- and let's put the dam at 47 metres instead of 127 metres. 47 metres is the same height as Neelum-Jhelum, which you saw on the field trip. It is still not a small dam. But at 47 metres at this site, my operating pool depth for the same volume is now 24 metres. I've gone from a 4-metre operating pool to a 24-metre operating pool by changing the height of the dam.

To put this into perspective, remember yesterday I talked about Kali Gandaki, that plant in Nepal, that has 40 million tonnes of sediment a year, which is double the sediment load at Baglihar: that plant is operated and manages sediment with 6 metres' operational range. 6 metres.

And India, by selecting the height of the dam, is basically selecting the allowable operating range under the Treaty. So if you select a very tall dam -- remember to think of it as a triangle: the dam gets deeper, gets taller, gets wider, it gets longer; you know, mile-wide and inch-deep -- so what happens is that you end up with a tall dam with a very restricted operating pool. And what you've done is: by your design choice, you have created a complicated sediment management problem. In other words, you've selected

10:32 a design configuration which makes it difficult to use Treaty-compliant methods instead of non-compliant methods.

(Slide 10) Now, here are the same two sites: here on the left is the Neelum-Jhelum height of dam, here on the right is the Baglihar height of dam, and they're represented here true to vertical scale. And what's the difference? I can do either one of these on the river. But I'm going to trade off a tall dam and a short tunnel versus a short dam and a longer tunnel. Okay?

(Slide 11) Here it is represented in a different way. Same two projects, configurations on the same river. Here we have the turbine powerhouse at the same level in both cases. These are again true to scale vertically. Here you have the tall dam, short tunnel; and here you have the shorter dam, long tunnel.

Why should we worry about long tunnels? I don't know. Dul Hasti has a 9.5-kilometre tunnel. Pakal Dul, which is under construction now, has also a 9.5-kilometre tunnel. Kishenganga, a 22-kilometre-long tunnel. So building long tunnels is not something that India does not know how to do.

Now, let me just address one other issue here. If you have this tall dam, now you're going to start talking about, "We need to flush". And we talked

10:34 a little bit about flushing yesterday, and how you have the cost of forgone power, et cetera, but I didn't give you any numbers. So let's think about the specific case of Baglihar.

Based on the level of the outlets at Baglihar, from the outlet level up to the full pool, we have 208 million cubic metres. So let's take 200 million cubic metres. We're going to empty this to do a flushing event. We're not going to empty it all at once, because that requires a downstream discharge of more than 2,000 metres a second. So you're going to flush during the monsoon season, when you have good flows, because remember you want good flows to efficiently remove sediment and have as wide a flushing channel as possible.

So we're in the monsoon, we've got this flow, and we're going to release water downstream, not all on the same day. And just for round numbers, let's say we're going to release an additional 700 metres a second above the inflow rate, which seems kind of reasonable. So it's going to take me three days to lower this reservoir, and I'm not producing power for three days, 900 MW. Okay?

Now, once I've gone down to my low level, I'm really starting to release a lot of sediment. And you can't

10:36 release 20 million tonnes of sediment in one day. It just will not happen. Physically, the river will not move that much sediment, and to put 20 million tonnes in one day downstream is disastrous. So we'll just use, for this discussion, five days of flushing. We're going to remove 4 million tonnes of sediment per day and push it downstream.

So we've got three days of drawdown, we've got five days of flushing, and now we have to refill it. But we're not going to close the gate and turn the river off downstream, to leave the fish flopping on the riverbed; we're going to continue to release flows downstream. So let's say that the refill period, let's take another couple of days. So we've got basically three plus five plus two: that's ten days to do this flushing event.

And let's assume that the electrical power costs 5 cents a kilowatt hour, which is $50 a megawatt. I don't know what India's rates are, but this is a fairly typical rate for new power plants, new hydro plants. If you get a PPA, you're looking at -- it depends on the country, of course. But $50 a megawatt is a very reasonable number: it's neither high nor low. Although as Peter showed the other day, the cost of new hydro production facilities is increasing over time.

10:37 But at $50, we're talking about on the order of $13 million to do that flushing. First of all, you released 200 million cubic metres through the gates: it didn't go through the turbines. There's $3 million of power lost right there. And then all the flushing period, all the inflow that you're not passing through the turbines. So you've got $13 million worth of cost to do this flushing event. And for $13 million a year, you could buy new runners.

But that's not all, because you have someone else downstream: it's called Salal, another 690 MW. And when you're flushing and releasing 4 million tonnes a day at Baglihar, you're not going to run that through the turbines at Salal.

So you've got at least a minimum five days that Salal is not going to operate. And because you have deposited all the sediment in the river all at once, your non-operation period at Salal will probably be closer to -- you know, it may be ten or fifteen days, because you don't want all that sediment coming through the turbines. But we'll just use five days. And the last day of our drawdown plus our five days of flushing makes six days at Salal where you're not going to be producing power: another $5 million.

So now $13 million plus $5 million: now you're at

10:39 $18 million for one flushing event.

So yesterday I mentioned that flushing is not cheap. And this is just the cost of forgone power. If you have anything else you have to do -- any type of mitigation work, any type of compensation work, anything -- it's going to be more than this $18 million.

Yes.

THE CHAIRMAN: Dr Morris, that point is clear.

I'm interested in your thoughts on: when this flushing occurs, does the dam operator successfully remove the entire bed load of the sediment, or is it typically just a partial removal? And whatever the amount is, how often would you need to repeat the flushing in order to achieve what you're trying to achieve?

DR MORRIS: Okay. At Baglihar, what you will have is mostly sand and silt. The bed load will be quite limited, for a couple of reasons. Remember on the first day I showed you photographs of bed material in some Himalayan rivers, big material, and that doesn't move very rapidly. So you're going to have a limited movement to begin with.

And upstream of Baglihar, we have Dul Hasti, which acts as a gravel trap for the large sediment, and they're also making Pakal Dul. So the upper part of the

10:41 watersheds will be cut off in terms of supply of large material: gravels, cobbles, et cetera.

So you're basically dealing with sand and silt. And what you want to do in flushing is you want to have your annual flow of sediment come in, and you want to balance that with an annual discharge.

So I mentioned 20 million tonnes a year; this is from India's rating curve and the daily data. And what we get, of course, is: some years have more, some years have less. So this is the long-term average. So the operator will pass -- on a timeframe of, let's say, five years -- 100% of that downstream. If some years he sees that he's passing not enough, then the next year he may flush for five, six, seven or eight days; whereas another year he might flush for only two or three days.

The problem though is: if you do this flushing on an annual basis, you can move it downstream more or less regularly; but if you start saying, "I'm going to flush every other year", then what happens is that instead of having 20 million tonnes to deal with, now you've got 40, and you've got to pass 40 down in a flushing event, or two flushing events. And then you say, "Well, am I going to do two flushing events in a monsoon?"

And of course, every flushing event here, the dollar cost is not related to the sediment release: it's the

10:43 dollar cost of the water that doesn't go through the turbines. So if I flush twice a year, the dollar cost basically doubles.

Now, if I did have a significant bed load -- and we saw this at Kali Gandaki, there's nothing upstream preventing it: we were seeing gravels being flushed through the reservoir. Not very much gravel was coming down the system, there wasn't very much, but it was passing through the reservoir and moving downstream.

So it will pass much of your bed material; not the boulders. But that is also why you need to do this with high discharges, because high discharges move that material. And of course, targeting periods of high discharge means that your rate of drawdown is limited because you already have flood conditions and you can't suddenly release 200 million cubic metres downstream to create a monster flood.

So hopefully that has answered the question.

THE CHAIRMAN: Yes, I think so.

Would it be correct to say that the typical approach to doing a flushing would be on an annual or a biannual basis, not: we wait five years, we wait ten years and then we do it?

And then the second proposition would be that the objective is not necessarily to clear out all the

10:44 sediment from the reservoir, but to maintain a stable amount within the reservoir?

DR MORRIS: Correct.

(Slide 11) Answering the second one first, what you will have -- follow the red dot, go about halfway up the dam, and you would have a profile that goes from halfway up the dam up until the upstream part of the reservoir. So what you're doing is you're basically raising up the riverbed up to the level of the low-level outlets. And then that becomes a new profile through the reservoir which you maintain by these flushing events.

Baglihar is big: flush it once a year. Small reservoirs, like one of the ones I showed you schematically yesterday that we worked with in Nepal, we're looking at two, three, even four flushing events a year, because the reservoir is very small and there's very little capacity to store sediment.

And of course at Kali Gandaki, which is a sluicing operation, you are essentially flushing continuously, and the profile of the bed hits the top of the spillway crest, and your operating pool is defined from the spillway crest up, and that's 6 metres of operating level. Your gates of course are higher, because your operating level is within the range that you can operate your intake.

10:46 So ...

THE CHAIRMAN: And if you were trying to gauge the amount of water within a reservoir that was available for potentially flooding downstream, you would need to take account that there's going to be some percentage of the reservoir that's been filled up with sediment, and therefore leaving a pool of water, if you will, above that bed load, that that's what's available for the flooding event?

DR MORRIS: Yes. And that's why I put these numbers based on 200 million cubic metres, not 400, because the bottom 200 million cubic metres is going to be full of sediment. So these numbers are based only on the volume from the outlet on up.

DR BLACKMORE: For Baglihar, for example, how long does it take it to fill up to the sill level of the low-level outlet of sediment?

DR MORRIS: From the information that we had originally from the Baglihar case, we're probably looking at something in terms of -- round numbers -- 30 years. Because if you've got 20 million tonnes a year, you're going to have a bulk density of about 1.4 tonnes per cubic metre, so you will fill up your bottom 200 million cubic metres in a little less than 30 years. Well, about 30 years.

DR BLACKMORE: So while that's filling in, presumably it's

10:47 taking a proportion of the sediment coming in, it's falling into that space. So do we know how much of the sediment load coming in -- some going into storage, and the rest being viable to be passed down -- do we know what percentage that is?

DR MORRIS: We do not know. We do not know. That information is not available to us. But let me just give you some insight from long-term simulations that I've done on some of the Nepali reservoirs, which are storage reservoirs, not small ones like the Kali Gandaki, which is a run-of-river.

But what we see is that you initially have a delta that advances into the reservoir, because the Himalayan sediments tend to settle pretty quickly. And you can wait until the delta reaches the dam, but that's not a good strategy. Because what happens is: when you draw down, then you're going to start cutting into that delta material, and your initial years of flushing will have huge loads going downstream.

So the recommended procedure would be to start doing drawdowns maybe five or ten years into the operation, so that you start moving this profile towards the outlets gradually. You do not want to all of a sudden, "Well, it's reached the dam, now I have this big pile of sediment, my outlet is down here, I have to flush", and

10:49 now you're going to cut through this, and that's where you're going to get concentrations of a couple of hundred thousand milligrams per litre. Your riverbed downstream is going to go up, people's houses are going to get flooded; it's not good.

DR BLACKMORE: So does a dam like Baglihar have the potential to have a delta?

DR MORRIS: It will have a delta, for sure.

DR BLACKMORE: How far into the dam is it likely to go?

DR MORRIS: It would go all the way to the dam. It depends on the way they operate it.

Just like Tarbela: it's the same type of sediment, basically. It's the same hydrology, basically: it's Indus River hydrology monsoon, and you will get this delta.

And the top of the delta will be defined by the operating level. If they maintain it at a high operating level -- and at this site, they only have a 4-metre-tall pool. So if they maintain it within that level, that delta is going to fill up the reservoir almost a flat line to the dam. And that's what we see at Tarbela.

DR BLACKMORE: So this dam has been around for a while now. So do we have data on what that looks like right now? Baglihar, I'm speaking about.

10:50 DR MORRIS: We don't have data on what's happening in that reservoir. What's happening in the reservoir is happening underwater. I can look at Google; I can't see it.

DR BLACKMORE: Yes, okay.

THE CHAIRMAN: Very good. So please proceed. I do note that we're about ten minutes from the normal coffee break, so I leave it to you, perhaps, Dr Morris, to let us know when there might be a good break.

DR MORRIS: Okay. Let's try one more topic here: outlets below dead storage.

(Slide 12) "There shall be no outlets below Dead Storage Level, unless necessary for sediment control or any other technical purposes; [and] any such outlet shall be of the minimum size, and located at the highest level, consistent with sound and economical design and with satisfactory operation ..."

The key concept here is the concept of necessity. It's considered a necessity if a practical way of achieving this or practical alternatives exist, independent of whether it is the least-cost solution. Because least-cost solutions are not necessarily the best solution in any environment. When you go buy a car, you don't buy the cheapest car: you buy the car that's most suited to your purpose.

10:52 The design necessity is frequently found in engineering of dams. There are dam safety requirements that establish a variety of necessities. One, for instance: we have what we call the n-1 criteria for gate design. You have multiple gates on your reservoir, and at any point in time, one of the gates may fail; it may be out of service for maintenance. So you design your dam to discharge your design flood with one gate out of service. That's your n-1, the total number minus 1. That adds cost, but it's a necessity.

The power intakes is an outlet that has to be below the dead storage level. Because if you're not below dead storage, you can't, of course, divert water into the intake.

The spillway crest must also be below the dead storage level for sediment sluicing. If it's higher than the intake level, you're not going to be able to control the sediment in front of the intake.

But as we showed in the previous slides, if you select a tall dam with a very limited operating pool, your design strategy -- the designer will artificially create the appearance of the necessity of having excessive drawdown, when in fact that drawdown is simply a consequence of a design decision.

And once you have created the artificial need for

10:54 a necessity to draw down, then this leads to design and operational procedures to correct the problem that was created from the onset by the design that you selected. And this produces absurd results which violate the very heart of the Treaty's intent, which is to limit the controllable storage in Indian dams.

(Slide 13) Now, remember the concept of controllable storage. We have pondage, which is at the top of the reservoir, but the gates really define what you can control. And when you have large low-level gates, sized to pass the design flood, then everything above that gate becomes controllable storage.

Now, you look at the pondage volume at Baglihar and the controllable storage at Baglihar: pondage is 32.5 million cubic metres, controllable storage is 209. Controllable storage is six times larger than pondage. So controllable storage has a much greater potential to impact downstream hydrology than pondage.

Let's look at this realistically now. These are the dams --

THE CHAIRMAN: Excuse me, Dr Morris. Sorry.

DR MORRIS: Yes, Dr Blackmore.

DR BLACKMORE: Can we go back to the last slide for a second?

DR MORRIS: Sure.

10:55
DR BLACKMORE: I'm a bit slower than the other people here, so it takes me a little while to get into gear.
(Slide 13) So I'm looking at this, and nothing you've said I've got an argument with.
DR MORRIS: Okay.
DR BLACKMORE: But I'm just trying to understand. So a minute ago we talked about -- we're talking about Baglihar now.
DR MORRIS: Mm-hm.
DR BLACKMORE: We're talking -- at Baglihar, let's assume that we've got this particular facility here, so we've got a delta profile going up. So we have immediately reduced some of the storage capacity, somehow.
DR MORRIS: Mm-hm.
DR BLACKMORE: So the controllable storage is 209 minus the amount occupied by sediment.
DR MORRIS: Okay. We have 400 at Baglihar.
DR BLACKMORE: Yes, in total.
DR MORRIS: Okay. So the bottom 200 --
DR BLACKMORE: Yes, yes.
DR MORRIS: So this is a level pool, controllable storage.
DR BLACKMORE: Yes.
DR MORRIS: And if they flush it effectively, the river is -- it's a fairly narrow valley: you will have a fairly deep flushing channel. Your side slopes, from

10:57
what we have seen at other -- for instance, in the Warsak flushing, we expected the side slopes will slough off, and that they will be able to control -- permanently maintain open for storage -- a very significant part of that 209 million cubic metres.
I have not done simulations of Baglihar, so I do not have a profile of that equilibrium profile. But your controllable storage initially will be 209. Within 50 years, with flushing being conducted, it would be something like -- just to use a number, let's say 150.
If they never draw down below dead storage, then your controllable storage will become in the range of maybe 50. But then they have the problem of: how are they going to manage the plant?
DR BLACKMORE: So they've got a trade-off.
DR MORRIS: Yes.
DR BLACKMORE: So they're running an active trade-off on the economic performance of the hydroelectric facility, keeping active storage. So there's plenty of moving parts.
DR MORRIS: Yes.
DR BLACKMORE: And it's a matter of choice and management choices.
The point I'm trying to get to for myself is to see what active steps they have to take to keep the maximum

10:58
pondage, if you like, to -- listening to you, to be a nuisance, that can be used in a way that would be difficult for other participants.
And then you went on to say -- so just take it for this, I just want to understand. So this is in a sequence of dams. There's one downstream that has got sediment issues as well.
DR MORRIS: Yes.
DR BLACKMORE: So when you look at them as a tandem set of facilities, and there will soon be other ones, presumably -- I didn't quite close the loop. You've just moved the sediment from this dam to the next dam down.
DR MORRIS: Okay.
DR BLACKMORE: So what's the combined controllable storage? How does that then, between the two dams -- which is what you would be worried about in terms of potential threat, weaponisation, or however you want to describe it. So I'm just interested to know.
DR MORRIS: Two quick answers.
First of all, Salal downstream is completely sedimented, so we don't have storage there.
And your second answer is on the next slide (14). What do they say: great minds think alike!
Okay. On the left-hand side -- did you want to

11:00
break for coffee at this point?
THE CHAIRMAN: If now is a convenient time, then yes, I think we should take a break, and we'll come back and start off with this slide. Thank you.
(11.00 am)
(A short break)
(11.28 am)
THE CHAIRMAN: Okay, I think we are reassembled. So, Dr Morris, whenever you're ready, please proceed.
DR MORRIS: Yes. Following up on some of the questions that were just being made, I prepared a small sketch on the iPad, and maybe if we'd like to put it on the click-share, you can see it, and we can just really briefly discuss a couple of concepts.
The concept that I was talking about with respect to the ... Okay. Here is the dam, and here is your low-level outlet: you see it part way up the dam, right here. It's shown with a red arrow. This is the outlet. So we can bring water out of the outlet.
And upstream we have the delta, which is a characteristic formation that we see in Himalayan reservoirs, reservoirs that have a lot of sand and coarse silt. We see this pattern in Tarbela very distinctly. And over time, if you maintain the operating level very high -- and let's put this dotted

line to show the minimum operating level -- you can expect this delta to advance basically in this pattern, just advance forward. And again, this is what we've seen at Tarbela, developing over decades.

Now, what you want to do is you want to develop a profile through your reservoir, which I'm drawing here as a red line, it will look something like this. This is your equilibrium profile. And everything under here will be permanent sediment deposits.

So when you operate, you would normally want to draw your reservoir down so these deposits which I'm showing here, circled in red, don't become really huge. Because when they reach the area of the dam, then you have this type of situation. And if you draw down to do any flushing, for instance, then you have the need to evacuate this material. That's why, if you do flushing, you would do it every year. Of course, if you have a smaller dam and you have very limited deposits, you essentially avoid that problem.

So I hope this clarifies the placement of the outlet on the dam. And some of the sediment will be permanent deposit, and everything above that permanent deposit line can be removed if you operate for flushing, which of course is not Treaty-compliant. And that's why, when you have an operating pool of only 4 metres, it puts you

into a rather uncomfortable situation. You know, you've just made the problem worse for yourself through your design decisions.

So I think that's -- I will provide a PDF of this to go on the record. But we can go back over to the presentation now.

THE CHAIRMAN: Dr Blackmore.

DR BLACKMORE: Thank you.

I just want to ask a question that goes before that one, and it came from your presentation before the break, where we had the small dam with the tunnel and the larger dam. I'd just like to get your view. I take it you've been in this industry for more than five years: like me, you've been around for a day or two.

DR MORRIS: Or three!

DR BLACKMORE: So what I'm looking at, I'm looking at these very large dams, and the alternative, you've got small dam and tunnel. I am going back to World Commission on Dams days when we took evidence in the region about dams and development effectiveness -- nothing to do with the Treaty -- but we started to see an emergence of new technologies related to tunnels, boring machines and the like.

I'm just interested in -- many of these dams

I suspect were designed in the 1950s or 1960s in concept, but we've seen this emerging technology with tunnels in the last 20 years, pretty much, from my perspective. But I'm interested in your perspective in the region.

So when people got confident, we got to see dams with these large tunnels: Neelum-Jhelum and so on. When has there been a high level of confidence in tunnelling in the Himalayas? How long ago would you say that technology became a force?

DR MORRIS: Tunnelling in the Himalaya of course is more difficult than many other areas. But the development of TBMs, tunnel boring machines, has developed remarkably over the last, let's say, 30 years. Tunnelling geology has remarkably improved.

So I would say that more or less we're looking at, in general, a timeframe of 30 years. But of course, if you look at technology starting in the year 1900, you've got 120 years, and every decade there's significant improvement. So there's not really a critical point. But certainly the development of effective TBM machines is relatively recent decades.

DR BLACKMORE: If I follow that line of thought, we've got a legacy of what you'd call "historically designed" dams that come out of the technologies of the 1950s and 1960s

and the like, and we're still seeing the legacy of those.

Do you see, in the current forward-looking projections, a move towards the sorts of configurations -- not only in the Himalayas but other areas -- small dam, long tunnel?

DR MORRIS: I would not characterise it that way.

Most of the construction in the Himalayas is relatively recent. You have to put it, first of all, in that context. And so we're not looking at long-term trends over the last 50, 60, 70 years. The Himalayan developments, particularly the ones that are in challenging areas, are quite recent: 20-30 years.

What we do have is studies that were done, let's say, in the 1950s and 1960s which identified -- you took the river system; there was no project. You send your geologists out, you do some flow measurements. And in the 1950s and 1960s, you'd lay out your system: here's a good dam site, here's a good dam site, here's a good dam site.

And you develop this based on 1950s technology. Because if you're developing this in the 1950s, so that you have a plan by the year 1960, you know, 1960s is using 1950s technology. So you develop this and you don't have the benefit of today's understanding and

11:37 today's technological capabilities, particularly, as you mentioned, with respect to tunnelling; and also, of course, with respect to the design of dams.

You saw that the Neelum-Jhelum, that dam is built on a fault. At one time, people would have said, "We can't do it". But as you develop technology, you're able to do development on sites which are increasingly challenging.

So what happens, as an unfortunate consequence, is that you end up with a "system of dams", or a layout of your system, which is based on technology from 50-60 years ago, which might not be the best way to do it today. But nevertheless, by 1960 they knew about the restrictions of the Treaty and they also had the potential to modify any pre-existing designs to be compatible.

So that's about all I can say about it.

DR BLACKMORE: So if I was in the region and I had the Tarbela experience, where the bypass tunnels collapsed and created havoc until they were repaired, and I live in this region and I'm at the end of the Himalayas, how would I deal with that in terms of my design decisions for other large facilities?

I'm just asking the question rhetorically, more or less, to say that there have been issues around tunnel

11:38 construction in the region that have highlighted the level of difficulty. So I'm just trying to get an understanding of where you see the development of them for these long-planned large interventions.

DR MORRIS: Yes, and Tarbela does have notoriously difficult geology.

Okay, let's move to the next slide (14). And here we're going to talk about controllable storage.

Now, there is Annexure D, which talks about the run-of-river projects, and these projects are supposed to have a very limited storage capacity. And I was struck the first time I read the Treaty, many years ago, that when they talked about interference with flow, et cetera, they even made an exception for bridge piers. The pier of the bridge is going into a river, and that, of course, will give you some obstruction to flow. They said: no, bridge piers don't count. I have never seen that type of language anywhere.

And if you are thinking that a bridge pier needs to be cited as an exception, this indicates that there is a real desire, in the formulation of the Treaty, to very strictly control the ability of India, in its run-of-river plants, to manipulate flow and retard flow and otherwise change the hydrology coming into Pakistan.

So you have the Annexure D plants, the run-of-river

11:40 plants, that have this very strict storage limitation, closely defined pondage volume; and then you have the storage plants under Annexure E.

Now, on the Chenab, we have one Annexure E plant, and that's Pakal Dul. It's been designed for 108 million cubic metres of live capacity. And you see that in the right-hand diagram circled in red. But when you look at the controllable storage, which we define based on the low-level outlet location, Baglihar -- which is a hydropower dam under Annexure D which should not have much storage -- actually has twice the controllable volume of the storage project.

So how can a storage project have 108 million cubic metres of storage, whereas Baglihar, which is a run-of-river plant, has double that controllable storage, as controlled by your low-level outlets? That can't be right. I mean, this is absurd, that the Treaty would allow an Annexure D plant to have more storage than an Annexure E plant.

So how does this happen? And here we come to the location of intakes and the relocation of your low-level outlets. You can develop an intake -- we will call it a surface intake, a high-level intake -- which is designed to withdraw water from the highest level possible. We can separate the intake, which is the

11:42 point at which the water departs from the reservoir, and we separate the intake from the entrance to the headrace tunnel.

(Slide 15) Now, what India does of course is they do not use any type of barrier in front of the headrace tunnel. They said the headrace tunnel entrance is the intake, and therefore we have to have a certain level of submergence below the dead storage level for the concept of anti-vortexing. And the result is that instead of having an overspill-type intake like this one -- which is actually the type of intake which was used at the Kali Gandaki project in Nepal that I showed the pictures of yesterday -- you end up with a pretty deep intake. And this intake has to be protected against sediment. And because it has to be protected against sediment, then you have to put your outlet below the intake.

Now, here comes the second part of the problem. Your outlets -- it's a spillway, it's an orifice spillway. And so you know that you have to have a spillway capacity equal to design flood.

(Slide 16) Now, here is the design flood for Baglihar: it's about 17,000-and-something metres per second. And you have to design for that. And if I put that gate size at an elevation lower than my intakes, now I have a deep intake and a much deeper

11:44 spillway. So by selecting my type of intake, I push it down; and in selecting my spillway, I go down even lower; and by making the spillway capable of passing the design flood, it becomes a very big and very deep spillway. Yet I don't need all of that capacity for passing sediment.

Why? Your design flood is more or less a 10,000-year event. How many 10,000-year events are we going to experience in Baglihar in the next 100 years? Not terribly likely. But we will be passing sediment, once the system is stabilised, every year. So you're designing in the long term for passing sediment every year.

So the flows that you will be using for sediment management are not even the flows that are shown on the bottom part of this graph, which is the maximum day of each year, because you don't know in advance what that maximum day is going to be. So ideally, if you were able to prognosticate this, you could say, "Well, I know that next week we're going to have the flood of the year, so I'm going to set up the flush". You don't know that: you never know that. So you flush during a period or you do your sluicing during a period when you have the anticipation that you'll have good flows.

So you're not managing sediment and either sluicing

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11:46 or flushing based on your 10,000-year flood, based on your 100-year flood; you're not even managing it based on your 25-year flood. You are managing it primarily based on floods that occur every year, and that may occur with some limited frequency: maybe a 5- or 10-year flood, let's say. And that's the capacity you need for your outlets. And you design that capacity through simulation modelling.

So what happens, going on to slide 17, is that -- on the right-hand-side graphic I have a gate configuration which is not Treaty-compliant, because I have put the gates having the entire capacity of sediment management plus flood control below DSL. But the Treaty restricts the capacity below DSL, and the only necessary part that occurs below DSL is what you need for sediment management.

So let's move to the left-hand side, and you can see what I've done is I've, for graphic purposes, shown this as a single crest gate. This lower part of the gate is the capacity that I need to pass my five- or ten-year flood at DSL. That's what I need for sediment management every year. Every year.

This higher part, that's where the reservoir is going to fill during my design flood, and it's going to fill up to the limit of the maximum flood level in the

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11:48 reservoir with the gates open.

So what you do is by limiting the gate capacity below DSL to only that flow needed for sediment management, you have made the gates to the minimum size necessary. Because you can put -- and this is very typical in dams: you have a spillway at the top, and the flood goes over the top of the dam, it doesn't go out of the bottom; obviously there are dams with different spillway configurations. But the concept here is that the only thing that's necessary below DSL is the capacity to pass sediment, your smaller events. Your monster event, you're going to pass that with a gate that's at a higher level.

So paragraph 8(d) is a design constraint that can be accommodated by providing spillway capacity necessary for sediment management below sediment level, below dead storage level, while the balance of the capacity used to manage the design flood is placed above dead storage level.

And of course, as we discussed previously, this depth between the dead storage level and the full pondage level, the depth of your operating pool, is defined by the selection of the height of your dam. It's a design which is basically where you're going to place the dam on the river, your tunnel length, where

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11:49 your power plant is going to be. It's the very first conceptual thing that you address.

(Slide 18) To do this analysis for a gated spillway, you provide your gate configuration, you develop your discharge relationships for the gates and you run sediment transport modelling. And you look at different gate levels, different gate capacities, and find the gate capacity that (1) will pass sediment, and (2) then you use the remaining capacity above DSL to give you the capacity to release your design flood.

And you go through multiple iterations of gate configurations, different operating rules, and you select the configuration that provides the highest level crest and the minimum size below DSL. And in that way, this is the iterative procedure by which you are able to comply with the Treaty requirements.

And this is a very standard procedure for sizing gates and dams. You don't set out and say, "This is where my gates are, and that's the final solution". The design will typically progress through a series of different configurations, and fine-tuning of those configurations, until you find the correct or the optimal solution.

(Slide 19) Intake placement:

"The intakes for the turbines shall be located at

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11:51 the highest level consistent with satisfactory and economical construction and operation of the Plant as a Run-of-River Plant and with customary and accepted practice of design for the designated range of the Plant's operation."

And of course this means the customary practice for a run-of-river plant, not for a storage plant. Storage plants typically have a deep intake; run-of-river plants will typically have a high intake.

Due to the settling velocity of coarse sediment, as we discussed, your concentration of sediment at the top of the water column is less than at the bottom. So therefore, where you have a run-of-river plant and you want to exclude sediment from the turbines -- the coarse sediment in particular, because it's much more abrasive than the fine sediment -- the accepted practice is to put your intake at the highest level possible to minimise the entrainment of sediment.

So in this respect, the Treaty requirement that the intake be at the highest level possible presents nothing out of the ordinary with respect to design of run-of-river intakes; in fact, it's accepted and recommended practice. And this, of course, is in contrast to the intakes at storage reservoirs, which are typically placed quite deep, because you typically have

11:53 a very considerable many metres, or tens of metres, of variation in water level.

And if you do install a deep intake configuration on a run-of-river reservoir, then that brings to you the necessity of maintaining deep water in front of that intake, through your design decision. If you have a skimming wall in front of your intake on a run-of-river plant, you're taking water off the top of the water column. But a deep intake, you're taking much deeper water, and then you have to have a deeper clear space with no sediment below that to minimise your entrainment of sediment. And that's what drives your intake level down and then your outlet level down even further, and this is what makes it not Treaty-compliant.

(Slide 20) So this little graphic here I think was presented previously, but it basically shows you the difference between a deep intake, on the left-hand side, and a surface intake, on the right-hand side.

The difference is, of course, that on the surface intake, the intake is where you take the water from the reservoir; it's not necessarily the entrance to the tunnel. And in fact, in a run-of-river, it typically isn't, because between the intake and the tunnel you will have a desander, just like you saw at Neelum-Jhelum. You had the intake, the desanders, and

11:54 from the three desanders they went into a collector canal, and from that canal, the water flowed toward the left, into the tunnel.

So basically, you are able to provide a high-level intake by separating the intake from the tunnel, and there's nothing unusual in this configuration. You would, of course, provide barriers to prevent floating debris from entry, trash screens, and all those normal things. But conceptually, there is no problem with this part of the requirements in the Treaty.

(Slide 21) Regulating basin. This is not an issue that is of concern between the parties.

But basically, what a regulating basin does is: when you have peaking plant, you turn the power on and off and on and off, so your river flows go up and down and up and down, and the up-and-down water levels cause bank collapse and erosion and caving in. It's not good for your ecology. It you have irrigation intakes, it will be extremely difficult to effectively divert water for an irrigation intake if the flow is going up and down every day.

So what a regulating basin actually does, it just takes this irregular flow, stores it, and has an outlet that converts it into, basically, constant flow.

So it's in the Treaty, it's a requirement under

11:56 item 8; it's not an issue between the parties.

(Slide 22) And now we come to weaponisation.

Pakistan is particularly concerned about the ability of India to manipulate water. Pakistan did have a bad experience early on when the water supply was interrupted. I'm not here to say who or why or whatever, but the fact is that it happened. And I've been working in Pakistan quite a number of years and I'm always reminded of this. So it's very clear in the minds of the people in Pakistan that: yes, this is a real issue.

And when we look at the world in general, it's not a trivial or abstract or academic concept. June of last year in Ukraine, the Kakhovka Dam on the Dnieper River was blown up to create a flood, apparently for military purposes. So the idea of weaponising dams is not an abstract concept.

And another interesting thing is that you have Pakistan and India: they both have conventional weapons, they both have nuclear weapons, but India is the only one that can control the water. There is no tit-for-tat here. India has the ability to control the water; Pakistan does not have an equivalent rejoinder, we might say.

So Pakistan is particularly sensitive to this issue.

11:58 And as I explained yesterday, the primary concern here is the interruption of water supply for irrigation. Flooding, being able to open the gates and create downstream flooding, is a secondary issue; and the sediment is a third-level issue. Primarily, supply of irrigation water.

Now, what I did to look at this -- because how serious is this, what's the potential? -- I created basically a hydrologic model. And what I did is I took the inflow time series we have in the vicinity of Baglihar and I put in 400 million cubic metres of storage. So the model takes the inflow, accumulates the water in the dam, and when the dam fills up, then it opens the gates.

Now, of course the whole 400 million cubic metres is not at Baglihar: we have multiple dams upstream. So you would operate the dams upstream to continue feeding water into Baglihar so that the whole system becomes emptied, and then the whole system closes gates and refills.

I didn't go to the detail of trying to model all the hydraulics. But the travel time between these dams is quite short, they're pretty close together: we're talking about opening the gate at one dam and having it arrive downstream in a couple of hours. So the routing

12:00 of the flows, it's not like you're trying to route something from one day to the next.

So the first thing I looked at was an extreme case: let's say that we open the gates, empty Baglihar, and all the upstream dams open their gates and all the water goes out, then we close all the dates and we accumulate water. Gates closed, no water leaving. What would be the pattern, the timing of flows below Baglihar?

And this is what it looks like. This is starting in the middle of the monsoon. In the middle of the graph -- and this is slide 23 -- in the middle of the graph you have the winter, and here around April and May you have the planting for the Kharif crop, the early crop.

And what it does is it shows that for this year, which is 1986, which is selected as the mean, the year having mean annual flow -- in other words, half the years in the time series are higher flows on an annual basis, half are lower flows, and 1986 also doesn't have any strange huge floods or anything. So this we can consider to be an average year.

And during the winter, I can store about a month's worth of water for several months running. I can store water for the month of November, release it at the end of November for a couple of days, start refilling;

12:01 middle of December, release for a couple of days; middle of January, release for a couple of days; beginning of February, another release for two/three days; March, another release for a couple of days, et cetera. Of course, in the monsoon period, it will fill much more quickly, so you'll have a very punctuated pattern.

I'm not saying that this is the way it would be operated, but it gives you an idea of the potential. And this is what, of course, worries everyone downstream.

(Slide 24) I also looked at a different scenario which is a little bit more, let's say, nuanced. And again, here you can see the red is the natural flow. And here, instead of cutting off the water 100%, I cut it off 50%, so that the downstream user is getting something. And if this was to happen, it might be more in this direction rather than the on/off. Because if you're getting some water downstream, it's a little bit easier to, let's say, hide what's going on upstream.

But here, look at what happens: you have periods of a month and a half between large releases, and you've cut the downstream flows by 50%. You have created -- from a natural year, from an average year, you've created an extreme drought.

So this is just a conceptualisation of the potential

12:03 magnitude, and the purpose here is just to put the whole weaponisation thing into some sort of a context on how consequential it could be.

Now, this is not to say that the existing Government of India is going to do this. But these dams are going to be here for a long time: hundreds of years. So there very well could be a point in time when the situations deteriorate to the point that this does happen. Remember, in Ukraine it was only a military exercise by Russia until they entered the border.

THE CHAIRMAN: Dr Morris, I think we have some questions for you.

Dr Blackmore.

DR BLACKMORE: Thank you.

I'm just interested in two aspects of this. One was the overall volume of water that eventually reaches Pakistan.

DR MORRIS: We have not looked at the volume that reaches Pakistan but the -- so I don't have this on the border. But because there is no diversion of water, this would be the same volume that would reach Pakistan. What would happen is that of course the flood flows would be spread out a little bit more in time.

DR BLACKMORE: Okay. So we've got the same volume. And so the issue then is there's obviously people who are along

12:05
these rivers directly that may be impacted. But the main irrigation development is downstream of the re-regulating facilities in Pakistan.
So I'm just wondering what the percentage of one of these periods, say in February to March, where you've held water for 30 days, what percentage of the overall water use by Pakistan, so downstream of Tarbela, would this represent?
DR MORRIS: Okay. The irrigation in Pakistan, most of it occurs in the summer. But Pakistan has two cropping seasons, and the critical part of the cropping season is the beginning of the Kharif irrigation in the spring. And that is the part that is most sensitive, because if the Kharif crop gets delayed, then the subsequent crop can itself be delayed, and that affects the productivity of both crops.
So that is why the Kharif irrigation season, April-May, is the most critical one. This shows the potential, assuming this happens repeatedly, repeatedly, repeatedly. But again, this is not a probable scenario: it just gives you an idea, if you chose to do this at this time of year, what would be its impact versus a different time of the year.
DR BLACKMORE: Yes, I understand fully. I'm just trying to get a scale on: if this is 0.02% of the flow that's

12:07
needed to support the Kharif, because you've got lots of other water coming in that is not controlled this way, I'm trying to get an understanding of that.
DR MORRIS: We can find numbers like that.
DR BLACKMORE: Yes.
DR MORRIS: But of course, because of the ways the canals were set up, the rivers are connected to specific canals. So when you have a shortage in one river that's at a certain part of this system, it's fed by gravity, that then will not have the water.
DR BLACKMORE: But the vast majority of the irrigation area is downstream, and re-regulating storage is under the control of Pakistan.
DR MORRIS: Yes, and most of it also comes out of either Tarbela or Mangla.
DR BLACKMORE: Absolutely correct. Alright.
So I'm just interested in the scale: I want to get an idea of what the magnitude is, in terms of ...
DR MORRIS: We can work up numbers on that.
DR BLACKMORE: So the second question then is that this comes at a cost to India, because they've elected to forgo generation -- or making the most of their generation, because I haven't really sorted out these numbers. But I presume they can't release this through the power station. And even if they could release it

12:08
through the power station, there's a sequence of days where they've had no power.
DR MORRIS: Yes.
DR BLACKMORE: And then, as I read this, there's far too much water to just go down through a power station, so some has to be released through a spillway facility.
So there is an economic cost to India. And I don't know what it is, but it's likely to be immense. So I'm just interested if you could conceptualise what it might be, and say, "Well, we're talking about a $100 million or a $500 million penalty". To weaponise it like the way you've described it, is it a $5,000 problem or a $500 million problem to India? That's what I want to know. Thanks.
DR MORRIS: You're totally correct about the turbines: it would not be passed through the turbines, they don't have the capacity. And of course, if you're passing through the turbines, then you're -- under the scenario where you're passing 50% of the flow, maybe you could run that through your turbines. But with the increase in the range of water levels, we would assume that most of it would not be generating power.
If India were to release large floods, it would, of course, be very damaging to India's infrastructure as well. The Salal plant which we mentioned is downstream

12:09
here. There's a number of communities that are downstream that would be impacted. And there of course is the cost of forgone power. It would be a very significant decision on the part of India to do this, not because of impacts to Pakistan but because of impacts to India.
So I totally agree with your line of thought, and I have thought about that quite a bit. And for that reason, I think that the probability of using this type of an operation is not high, because of the impacts to India. But at the same time, we see sometimes that things happen that we don't think make any sense.
DR BLACKMORE: I'm not trying to get to the bottom of the sociopolitical decision that would cause to go; I'm just trying to get a scale around the numbers so I get a sense of it.
I've worked in plenty of places where dams are designed particularly for weaponisation, and to wash tanks off causeways, all sorts of interesting outcomes. But this is not that. This is a way you can maximise the nuisance value of this reservoir to a neighbour, but it comes at a cost. So let's just find out what that is --
DR MORRIS: Yes.
DR BLACKMORE: -- so that that gives us a frame of

12:11 reference.
DR MORRIS: Final thoughts --
THE CHAIRMAN: Before you continue, Dr Morris, I have a couple of questions.
DR MORRIS: Okay.
THE CHAIRMAN: I'm just looking to see if others have any as well.
So the scenarios are very interesting. I'd be interested in whether the scenarios are driven mostly by a Baglihar low-level orifice versus a Baglihar pondage level that's higher than what Pakistan had hoped would be decided by the Neutral Expert.
DR MORRIS: This is driven by the low-level orifices and the volume of storage which is above that. And the volume of storage of 400 million metres which I use combines all that controllable storage across all of the dams.
THE CHAIRMAN: So if you were to eliminate the low-level orifice at Baglihar, but retain the Neutral Expert's pondage level, does that radically alter the scenarios that you indicate?
DR MORRIS: Yes, it does. If you considered that plus Ratle together, they constitute a large part of this.
And if we can go back a few slides. I recall slide 14, and it shows a controllable storage between Baglihar and Ratle: we've got 260 million cubic metres,

12:12 more or less. Pakal Dul is a storage plant. Salal has basically zero storage. And the other three -- Dul Hasti, Kwar and Kiru -- their storage is quite small and would not lend itself to this type of operation very well.
THE CHAIRMAN: I suppose what I'm getting at is: I can see the so-called "weaponisation" point as it relates to the low-level orifices. It's a little less obvious to me whether it speaks to the setting of the maximum pondage level at either a Baglihar Neutral Expert level or at Pakistan's preferred level, either in that proceeding or in this one.
DR MORRIS: And you are correct: the pondage volumes here are really insufficient to have a huge impact in terms of weaponisation.
Basically it's a problem of the placement and the capacity of these large orifice spillways. Because to release the water very quickly, to allow it to empty and then refill, that again comes from not only the location, the height of the orifices, but their capacity.
THE CHAIRMAN: So let's assume that the dams at issue, including Baglihar, do not have the low-level orifice. But let's further assume that there are storage facilities, storage plants of a magnitude permitted

12:14 under Annexure E.
Does the same weaponisation issue arise? Can you manipulate the storage facilities to bring about the scenarios you're referring to?
DR MORRIS: Yes. It doesn't matter whether it's labelled "storage", or what label you put on to it. The whole key to being able to control the large flow rates that are simulated here is the placement and the size of low-level outlets.
If you have a storage project that has a discharge at a low level which is limited, and then you have crest gates for handling the flood, that's completely different than if you eliminate most of your crest gate capacity, you only keep a small gate to discharge floating debris, and put most of your gate capacity near the bottom of the dam. That's the difference.
THE CHAIRMAN: Well, this may be a function of my not fully understanding the storage plants. But assuming that there are no low-level orifices in the Annexure D plants, is it the case that you could use the storage plants to bring about the same weaponisation that you're talking about in these scenarios?
DR MORRIS: The storage plants under the Treaty have a stated schedule for filling and releasing, and that's outlined in Annexure E. So that, for instance, during

12:16 the springtime, they have to deliver water volume which is equal to or greater than the natural inflow rate.
So --
THE CHAIRMAN: Right. But in your scenarios you're assuming non-compliance with the Treaty, I think.
DR MORRIS: Yes.
THE CHAIRMAN: So my question is: assuming you're non-compliant with the Treaty, could you use the storage plants in Annexure E to bring about the weaponisation you're talking about?
DR MORRIS: Correct. You could use a storage plant to release less than, or significantly less than, what was required by the Treaty.
THE CHAIRMAN: And bring about the same type of scenarios you're referring to?
DR MORRIS: The same type of scenario, correct.
THE CHAIRMAN: So --
DR MORRIS: But -- yes.
THE CHAIRMAN: So just to drive that home, even if there's no low-level orifices in the Annexure D plants, and even if the pondage is at a level that Pakistan is urging in this proceeding, there is already a potential for so-called "weaponisation" from the plants that are regulated under Annexure E?
DR MORRIS: Yes. The difference being that the volume of

12:17 the storage plant is significantly less than the volume of all the plants combined. So this limits your capacity. And remember, the storage plant is not on the main stem of the Chenab: it's on a tributary. It's a major tributary, but it's not on the main stem.

THE CHAIRMAN: Well, again, it may be interesting for us to learn a bit more about Annexure E, and to learn how you would relate that maximum amount of storage that is permitted in Annexure E to the existing active storage of Annexure D plants. You're making it sound as though it's much less in Annexure E.

DR MORRIS: It is.

(Slide 14) If you look at the left-hand side, controllable, Pakal Dul, the controllable storage is 147, and this is to the bottom of the low-level outlet. The combined is 453. So Pakal Dul is, what, one third. That's the storage plant.

THE CHAIRMAN: Right. But Pakal Dul could be higher than that as a storage plant, could it not, and still be compliant with Annexure E?

DR MORRIS: It could be larger?

THE CHAIRMAN: Sure.

DR MORRIS: I can't answer that right now. I mean, there's not enough in my mind as to what the limitations on storage are.

12:18 THE CHAIRMAN: That's fine. I suppose what I'm driving at is: there's an aggregate amount of storage that is permitted under Annexure E that's not driven by what's actually at Pakal Dul.

DR MORRIS: Yes.

THE CHAIRMAN: And whatever that amount is, if India were to exploit it to its maximum, I think what I'm hearing you say is it leads to a similar weaponisation scenario.

DR MORRIS: Yes, any storage could be used in an adverse manner. The point I'm trying to make here is that the way that the Treaty has been interpreted to date, you end up with actually more storage in your run-of-river plants than you have in your storage plant. And that's the point on which, as I see it, there is a real problem with the way that these things have been interpreted and resultant design.

THE CHAIRMAN: Judge Al-Khasawneh.

JUDGE AL-KHASAWNEH: Thank you, Dr Morris.

My question is with respect to the potential scenario of weaponisation. What effect would cascading have on this scenario which would take place? Would it augment the effect of weaponisation?

DR MORRIS: Okay, thank you.

The simulation that I showed here incorporates the assumption that the entire cascade will be operated as

12:20 a single unit for this purpose. So if you have a single dam, for instance Pakal Dul, it has a much smaller watershed and it has one third of the capacity, so the simulation would look quite different: much less impact.

THE CHAIRMAN: Dr Buytaert.

PROFESSOR BUYTAERT: Thank you, Mr Chairman.

Thank you, Dr Morris. A follow-up question on the relevance of the deep-level orifices in Baglihar, and potentially other plants.

I think in your answer to the question of Mr Chairman, you mentioned that it has a big impact. Which I can see in terms of the volume stored, because obviously it very clearly makes a difference in the amount of volume stored in Baglihar. But am I correct in assuming that it would not have much of an impact on the maximum floods you can create?

If you perhaps go to the next slide (23). So you have there a maximum peak volume, but you ... (Pause)

So you have here a maximum volume, or a maximum discharge, of around 9,500. Am I right that that's determined by the capacity of Baglihar, and potentially Salal, of the amount of water that the dam can release, which is directly related to the design of the 10,000-year return period design flood?

DR MORRIS: Correct. The gate capacity is actually a little

12:21 bit larger than this; this is actually an n-1 scenario.

So basically, the amount of water that can be released in a flood is dependent entirely on the gate location and the capacity. Of course, as the water level drops, the flow through the gate will decline over time.

But the capacity of a gate to release a very large flood, but with a limited volume of water -- for instance, let's look at Pakal Dul: it has a much more limited volume. And let's assume it has very big gates: I can release this instantaneous flood. But by the time it passes through Ratle, passes through Baglihar, passes over Salal and goes down to Pakistan, that flood will be -- there's no volume there, there's very little volume. It's not like I have rain occurring plus snowmelt, or rain on snow across the entire watershed.

So because the volume is limited, by the time it hits Pakistan, it will probably not be an issue from the standpoint of flooding.

PROFESSOR BUYTAERT: Thank you.

THE CHAIRMAN: Okay, Dr Morris, I think we're now ready for your final concluding thoughts.

DR MORRIS: Okay, yes. Real simple.

(Slide 25) The Treaty's limitations are clearly designed to protect Pakistan's hydrology. They are not

12:23 designed to satisfy India's desire to build high dams and maximise storage. India does have Treaty-compliant design options, but has simply ignored them.

So I think that concludes the key points that I wanted to make here. If there are any other questions, I would be happy to answer.

THE CHAIRMAN: Thank you, Dr Morris.

Professor Buytaert.

(12.23 pm)

Questions from THE COURT

PROFESSOR BUYTAERT: Yes. I would like to go back quickly to what you presented before the coffee break on the options of a large dam with a shorter tunnel and a small dam with a longer tunnel. You presented that as a design option where the engineer can choose which of the two, and I wondered how frequent or how regular it is that a certain site presents or allows for both options.

Particularly, for example, in Baglihar, from your understanding of Baglihar, would, in this particular case, the design of a small dam with a long tunnel have been a feasible option for that particular site?

DR MORRIS: I would anticipate the answer is: yes. Because if you look along the river, you will find places which are appropriate for dam construction and other areas

12:24 which are much less appropriate. And the dams along this river are not the only locations where you can construct dams. They were selected to not interfere with the communities: you don't want to flood towns and things like that.

So there are multiple dam sites along rivers. And when we have done -- like, we did an island-wide study in Puerto Rico, you know, it's a little, small area, and we came up with 200 dam sites pretty easily. There are lots of potential dam sites.

So it's not like this is the only place you could put a dam. And that means that they did have that option, I have to presume that they did have that option, and they selected this particular configuration for reasons unknown.

PROFESSOR BUYTAERT: Thank you.

THE CHAIRMAN: Dr Blackmore?

DR BLACKMORE: I'm just interested in getting the timeframe around Baglihar. I can probably go back and read the documents. But do you know when Baglihar was first conceived as a -- you know, in what ...

DR MORRIS: I do not know. Peter Rae may know: he was involved with that litigation. I was not involved with that at that time.

DR BLACKMORE: I'm just wondering whether it was a dam that

12:26 was conceived back in the 1950s or 1960s.

DR MORRIS: I'm sure that the Pakistan representatives will know that.

DR BLACKMORE: Okay, thank you.

SIR DANIEL: If it would be useful -- this, I think, Dr Blackmore, is not perhaps precisely your question, but you will recall that Pakistan first put in an objection in 1992, but of course it would have been conceived much before that.

We can come back. We will provide you with that detail.

THE CHAIRMAN: Dr Morris, let me build on a question that Professor Buytaert just asked you.

To the extent that there are multiple possible locations for the site of a dam, is it true that there would always be a possibility of pursuing a hydroelectric plant that does not involve a high dam? In other words, if we're trying to understand the idea in 8(d) of situations where it's necessary, for sediment control, to have an outlet below dead storage level, are you saying that there will always be a possibility of picking a site where there would not be a necessity for such an outlet?

DR MORRIS: I would tend to say: yes. And I will explain that in a couple of ways.

12:27 First of all, if you're going to do 100-150-metre-tall dam, your site options for that size of a structure are more limited than the options for doing a 40- or 50-metre-tall dam. So right off, if I'm going to do a small dam with a tunnel, I will probably have more dam sites available. For one thing, I won't have as much of an area that I'm going to flood. So socially I can place it closer to communities, for instance. It eliminates several types of problems.

The remaining problem is the tunnelling. And tunnelling conditions vary considerably. But when we are in the Himalaya, we have a lot of rock that's available. You want to tunnel typically in, of course, as strong a rock as possible. And you want to tunnel relatively deep, because shallow tunnels tend to be more problematic than deeper ones, because you have less overburden and it's a problem.

So from the point of dam construction, I think there's always going to be other sites. The tunnelling, you may have differences in tunnelling difficulty; but again, probably not insurmountable.

And you had the question yesterday about one big dam versus multiple dams. The other thing to remember is that you can't really do one big dam, because then your watershed is limited to the big dam; whereas multiple

12:29 dams along the river, you're picking up more water from the tributaries. So it's typically broken up anyway.

And this is the way Chenab was developed. Remember, you have Dul Hasti that has a relatively small dam and a tunnel; and then immediately downstream, you have Ratle, which is the opposite: it's a tall dam with a short tunnel.

THE CHAIRMAN: I suppose what I'm trying to understand is: if it is the case that there are always options for smaller dams, then why wouldn't we have seen 8(d) written in a simpler way: "No dam shall be above [X] metres"?

DR MORRIS: I read the travaux some years ago, and there was a lot of back-and-forth in that. For instance, we have had difficulty with the pondage issue, and that's one of the things that I said: why did they not define this better?

And one of the ideas that really came out to me is that you had two parties who were very opposed, and they had a deadline, and there were certain items they simply could not come to agreement on. I think that's basically what it comes down to. And that's where a number of items in the Treaty that you may say today, "Why did they do or not do this?", I think it comes down to that, because there was, let's say, a lot of bad

12:31 blood in those days.

THE CHAIRMAN: So you think there wasn't a meeting of the minds as to what was actually meant by something like paragraph 8(d)?

DR MORRIS: The Treaty was basically imposed upon the two parties. In other words, they had to come to agreement to get financing from the World Bank. And they were stuck that they can't finance the development that they need to do without having a treaty.

So the Treaty is developed, the parties are in opposing viewpoints. And there were certain things that they were able to agree on; and there were certain things that they couldn't really agree on the details, so they didn't.

That is my personal reading of it, and the team may have a little bit different way to express that. But that is my personal opinion, from what I saw from all of my interaction over the years, reading the travaux and watching the dynamic as it has evolved within the realm of my own experience.

SIR DANIEL: Professor Murphy, just to say, to save Dr Morris, we may be taking him into the territory of a lawyer. So if there are issues, then we'd be happy to come back to those.

THE CHAIRMAN: Yes, that's fine.

12:32 I appreciate your candour, Dr Morris.

We have another question from Dr Blackmore.

DR BLACKMORE: I'll stick to the technical.

I'm just interested in your take on seismic. We're in an area with very high seismic activity and, well, high risk. And looking at the way knowledge is evolving quickly around all of this, I'm just interested in your take on tunnelling technology in the seismic environment vis-à-vis high and low dams, where you see the balance or risks in that area.

DR MORRIS: I can't really go into tunnelling more than what I've already mentioned, in terms of we have seen a lot of advancements, because tunnelling is not my area. So I would have to defer that question.

THE CHAIRMAN: Mr Minear?

MR MINEAR: Mr Morris, this might be my last chance to ask an engineer this question. But we spoke the other day about the travaux, and how at one point Pakistan's negotiators had specified a minimum load factor as a way to regulate pondage, but they later, without explanation, switched to a bespoke definition of "Firm Power".

As an engineer, do you have any insights of why they would have gone from the minimum load factor as the criterion to the "Firm Power" definition?

12:34 DR MORRIS: I can't answer that, because it's been a few years since I've looked at the travaux. So I apologise that I can't answer it in detail.

MR MINEAR: Thank you.

THE CHAIRMAN: Okay, I think we are done questioning you, Dr Morris. But thank you very much for your presentation. It was extremely helpful and we're very grateful.

DR MORRIS: It's been a pleasure. And I will give the PDF of the sketch I made to the gentleman at the ...

THE CHAIRMAN: Very good. Thank you.

So I think that we are now moving on to a presentation by Professor Webb: "Outlets, spillways and power intakes". Perhaps it could be subtitled "from the perspective of a lawyer"!

So we welcome you, Professor Webb, to the podium.

(Pause)

While you're getting yourself sorted out there, I suppose I'll note: we have a little less than a half-hour before the lunch break, but I understand that Professor Webb's presentation will extend well beyond that. So if the top of the hour is a convenient time to make the break, Professor Webb, please feel free to let us know.

SIR DANIEL: Mr Chairman, just on that point, I anticipate

12:36 that probably we will get through Professor Webb and Dr Miles on freeboard this afternoon, and I might start off the day on the brief submissions on pondage tomorrow morning, so that we can not stress the timing on these too much.

THE CHAIRMAN: That's fine.

Professor Webb.

PROFESSOR WEBB: Thank you, Mr Chairman, members of the Court.

(12.36 pm)

Submissions on Outlets, Spillways and Power Intakes

PROFESSOR WEBB: (Slide 1) The Court has just heard from Dr Morris on these features, outlets, spillways and power intakes, and how they play a crucial role in controlling the water contained in the reservoir and managing sediment. The Court also heard from site experts during the Neelum-Jhelum site visit on how these are designed and operated in a generic hydropower plant. And you had a firsthand view of these features during that site visit.

I'm going to be placing these features in their Treaty context. Because we're no longer dealing with a generic plant, we're not dealing with Neelum-Jhelum; we're in the realm of the hydro bargain that I spoke to you about yesterday.

12:37 So outlets, spillways and intakes reflect the means by which an operator may control the water contained in the reservoir by opening and closing the means of discharge. And the extent to which the operator possesses such control, as you've heard, will depend on the position of each component within the reservoir: the deeper the component, the greater the control.

And consistent with the object and purpose of the Treaty, the paragraph 8 criteria can only be interpreted as a deliberate effort by the drafters to materially limit India's ability to store water on the Western Rivers and to control the use of that water that is stored. And that is the point of each criterion in paragraph 8. The deeper that India wants to place an outlet, a spillway or an intake in the reservoir, the more factors it has to demonstrate before the Treaty will permit that placement.

The water volume controllable by India includes not only the pondage, but also the additional volume below dead storage level but above the invert of the lowest outlet. And depending on the placement of the outlets, this controllable volume can be quite large. And this goes directly to the exchange that the Chairman and Dr Morris just had about the difference between pondage and controllable storage.

12:38 (Slide 2) This is demonstrated by this table, which is drawing on data on the record. So you see, for example, projects Baglihar, Kishenganga and Ratle, the pondage amount, but then the different number for the total controllable volume, which reflects that volume above the invert of the lowest outlet.

So we see Baglihar has a pondage of 32.56, but it has a controllable volume of 209 million cubic metres; Kishenganga, 7.55 of pondage, but a controllable storage of 17.94; and Ratle, as it's designed, 23.86 of pondage and 59.91 of the controllable volume.

So this exactly illustrates the point that you were discussing on the difference between pondage and controllable storage in terms of weaponisation and other uses.

I just want to pick up on your question about Annexure E plants and their potential role, given that they have different conditions under Annexure E. And we will be coming back to this, I'm sure, in the second round. But I just wanted to point you to paragraph 11 of Annexure E, paragraphs (e), (f) and (g).

So paragraph (e) provides, in relevant part, that the outlets:

"... shall be located at the highest level consistent with sound and economical design and the

12:40 satisfactory operation of the ... Work."

(f) provides:

"Any outlets below the Dead Storage Level necessary for sediment control or any other technical purpose shall be of the minimum size, and located at the highest level, consistent with sound and economical design and with satisfactory operation of the Storage Work."

And (g):

"If a power plant is incorporated in the Storage Work, then the intakes for the turbines shall be located at the highest level consistent with satisfactory and economical construction and operation of the plant and with customary and accepted practice of design for the designated range of the plant's operation."

So we see the hydro bargain, in a sense, being transposed to Annexure E in these provisions, because there are very similar -- if not identical in some respects -- limits on outlets, spillways and intakes.

So outlet placement is crucial.

Now, for each of these features, I'm going to briefly recall its function in a hydroelectric power plant, although we are now all very familiar with that, and then apply the Treaty interpretation. And I will, along the way, be referring to the analysis that was given by the Kishenganga Court and the Baglihar

12:41 Neutral Expert.

I will also be answering the Court's question 2(a) received on 20 June, which is that:

"The Court invites Pakistan to ... explain in as much detail as possible Pakistan's understanding of India's current interpretation."

Along the way, I will also recall questions posed and answers provided during the Neelum-Jhelum site visit and in Procedural Order No. 6. So I hope this will give a full picture of the legal analysis of these provisions.

(Slide 3) So I will first briefly set out the relationship between paragraphs 8(d), (e) and (f), before moving to interpret each of them individually: outlets, spillways and then intakes.

So the term "outlet" is a generic one in paragraph 8(d). Spillways and intakes are special types of outlets. And this is worth emphasising because, as Sir Daniel flagged this morning, 8(d) is the gateway to all kinds of outlets that appear in a hydropower plant.

(Slide 4) So in a generic hydroelectric plant, spillways are large-capacity outlets designed to discharge flood flows into the river below the dam. And as we've heard, they are usually used on a seasonal basis.

12:43 Intakes, in a generic plant, act as an outlet from the reservoir, as well as an intake for delivering water for beneficial uses. So in a generic plant, they deliver water for irrigation, municipal supply, industrial use and environmental flows to the river below the dam. We are going to be concerned with power intakes that divert water from the reservoir into the conveyance system supplying the power station.

Outlets may serve multiple functions in a hydroelectric power plant. A crest-gated spillway may play a role in sediment management but also enable the plant to safely discharge floods.

And Pakistan has no objection to such a dual-function spillway. This has arisen in the Commission. This is actually one of the features that India described as so-called "state-of-the-art". And there was no objection to India including dual-function spillways for that purpose in their designs, but always provided that the requirements of paragraph 8 are complied with.

Outlets, spillways and intakes may have common features, in that they pass water over and through and around the dam. But despite these features in common, we do see specifically different language in the three paragraphs that we're focusing on in paragraph 8. And

12:45 I'll be coming back to these in more detail and applying the principles of treaty interpretation. But just to highlight them now at the beginning.

(Slide 5) So in paragraph 8(d) -- which, as we said, is the kind of "gateway" provision dealing with any outlet that is below dead storage level -- this is governed by "sound and economical design and ... satisfactory operation of the works".

Paragraph 8(e), on spillways, refers again to "sound and economical design", and "satisfactory construction and operation of the works". It adds in construction.

And in paragraph 8(f), on intakes for the turbines, we have "satisfactory and economical construction and operation of the Plant as a Run-of-River Plant". And we have the addition of a phrase that has come up a few times this week, "customary and accepted practice of design for the designated range of the Plant's operation".

These differences in language are deliberate.

(Slide 6) Paragraphs 2(a) and (b) of Annexure D are relevant here as well, again coming to special meanings intended by the parties to be used in the implementation of this Treaty.

So "Dead Storage" is the "portion of ... storage ... not used for operational purposes", and that defines the

12:46 "Dead Storage Level". And "Live Storage" is "all storage above" that.

As the Kishenganga Court said, "Dead Storage" under the Treaty is "truly 'dead' -- an area to be filled once, and not thereafter subject to manipulation" (PLA-3, paragraph 505). This reflects the hydro bargain, which places on India an obligation to "let flow", as we know, and imposes limitations on interference and storage of those waters.

So this means that the only water in an Annexure D.3 HEP that can be used for operational purposes is live storage, which is stored above the dead storage level.

So with this understanding, paragraph 8(d), on outlets in general, places a strict prohibition, subject to very limited exceptions, on any outlets below the dead storage level. It also has no reference to construction, unlike the other two provisions. And this implies that the size and placement of outlets cannot be justified by reference to the cost or the difficulty of actually building them.

And this limitation is critical because whereas pondage is specifically limited within the Treaty, there is no limitation on the volume of water that can be impounded by way of dead storage. So this makes it critical that the depth of outlets below dead storage

12:48 level are strictly limited for purposes of constraining that controllable volume of water.

By contrast, spillways and power intakes under 8(e) and (f) tend not to be placed entirely below dead storage level. Where the intake is below dead storage level, then it becomes a low-level orifice that has to be justified by reference to the requirements in 8(d). You are not only in the realm of 8(f) if your intake is below dead storage level.

Paragraph 8(e), on spillways, provides that a gated spillway is not the default choice: it has to be justified as necessary by the conditions of the site that is being chosen. But even when you meet that condition of a gated spillway being necessary due to site conditions, there are additional requirements in 8(e): that the bottom level of the gates is located at the highest level consistent with various conditions.

And as I said, the use of "construction" appearing in 8(e) indicates that you may consider difficulties in actually building the spillway -- for example, due to geological or technical challenges -- you may take that into account in justifying the level of the bottom of the gate within the reservoir. However, if that structure is below dead storage level, you enter 8(d).

8(f), on power intakes and turbines, adds the

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12:50 requirement of being specific to the construction and operation of a run-of-river plant. And when I come to 8(f), I will deal with that in more detail.

(Slide 7) You've seen this slide a few times before, and it's just to make the point that an "outlet", in dam engineering, is any opening that will allow water to be discharged through or around the dam. And in a generic plant, it may be located at any depth. That is not the situation in a Treaty dam, which expressly restricts where India is permitted to locate outlets below dead storage level.

We've just heard from Dr Morris that the central function of an outlet is sediment management. And I recall the Court's question 2 asked during the site visit (Site Visit Day 4, page 92, lines 6-11), which was:

"What are the range of circumstances where an outlet below dead storage level might be either beneficial or required for a run-of-river hydroelectric project on the Western Rivers of the Indus Basin, in particular for the purpose of sediment control?"

And I recall the answer provided by the site expert. This is the site visit transcript, Day 4, pages 97 to 98. And he mentioned "two main circumstances", of course referring to a generic hydropower plant:

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12:51 "First, to release flow with the water level at the minimum operating level requires the crest of the outlet to be set below the minimum operating level.

Second, sediment management to maintain reservoir storage capacity requires establishing a new riverbed profile [as you see on the slide] through the reservoir ... The new profile will be defined by the water level at the dam during flood flows responsible for most sediment scour and transport.

However ... once the outlet has been set at the location needed to produce the target water level, further lowering of the outlet will produce no beneficial change in the profile other than to create a highly localised cone ... of scour at the upstream face of the outlet."

So as already explained by Dr Morris, sediment management has two aspects: first, it is to prevent sediment accumulation that's going to reduce your live storage; and second, it is to prevent or reduce turbine abrasion. And effective sediment management involves multiple techniques, and some of these would call for low-level outlets and some do not require low-level outlets. The key point is that there is a variety of techniques available. And I'll just recall those; I know you're becoming very familiar with them.

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12:53 (Slide 8) Pressure flushing for managing sediment requires a low-level outlet: it creates a scour cone. It will not address sediment accumulation along the length of the reservoir. This is really only a technique that can be used to remove sediment from the immediate area of the intakes.

(Slide 9) Another strategy also you're very familiar with now is empty flushing. You've seen this slide during the site visit, and you're familiar with the technique.

You've also been told, by both the site expert during the visit and by Dr Morris during these proceedings, the challenges of empty flushing, quite apart from its prohibition under the Treaty, in terms of its negative downstream impacts and its requirement to stop production.

So those are the low-level outlet techniques.

(Slide 10) But then we come to techniques that do not require a low-level outlet. And you've heard from Dr Morris about sluicing. And I recall this slide both from his presentation and the site visit.

Sluicing mimics the natural pattern of the river. And spillways located at or just below the minimum operating level are fully opened during the flood conditions to pass the floods through the reservoir at

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12:54 the highest possible velocity, essentially transforming the reservoir into a fast-flowing river. And Dr Morris took you through the seasonal drawdown, and how that operates during the time of year when pondage is not needed for power peaking.

The appropriate sedimentation management strategy will depend on a range of factors, whether you're in a generic plant or an Annexure D.3 plant. You're going to be looking at hydrology, at the sediment load, at the variation over time, at the river, at the reservoir geometry. You will also be looking at regulatory factors that are domestic, regional, international. For an Annexure D plant, you're looking as well at the Treaty.

(Slide 11) And with that, I turn to paragraph 8(d), which is the controlling provision on all outlets below dead storage level.

(Slide 12) And we can distil the requirements of that paragraph into a sequence of questions and steps to be followed.

First, India must show that the low-level outlet is necessary for sediment management or some other technical purpose.

Second, if it does show that it is necessary, then it must identify appropriate options with respect to

12:56 that outlet that comply with sound and economical design. That can include innovations, that can include best practices, that can include advances in design that have occurred since 1960. But it's informing a paragraph 8(d) analysis.

The third step is that once those options are identified, India must pick the design option that complies with the hydro bargain and with the requirements of paragraph 8(d), so the smallest and highest low-level outlet. Even a marginal decrease in the size and depth of that outlet will be enough for one design to be preferred over the other.

And finally, there has to be satisfactory operation of the works: performing its designed function in an acceptable manner. Construction, as I said, does not come into the paragraph 8(d) analysis.

(Slide 13) So I now turn to our application of Treaty principles to the various phrases of paragraph 8(d). So the first is the starting point, the default position:

"There shall be no outlets below ... Dead Storage Level ..."

As the Kishenganga Court observed, these opening words reflect the expectation of the drafters that India would have no capacity to control dead storage in its

12:57 reservoirs via the use of low-level outlets. As they said, it is "an area to be filled once, and not thereafter subject to manipulation" (PLA-3, paragraph 505).

(Slide 14) If the default position doesn't apply, if India has discharged the burden of showing that an outlet is necessary for sediment control or any technical purpose, we move to the second step.

So in terms of ordinary meaning of these terms, "sediment control" means sediment management to preserve live storage and to minimise the entry of sediment into the turbines.

"Technical purpose" means "having [a] special and usually practical knowledge especially of a mechanical or scientific subject" (P-526). Read in the context of this provision, it refers to the operation of the plant and its associated features.

So the outlet must be required for the operation of the plant as such, not connected with some other purpose. An example would be irrigation or water for domestic use. So we can say that a technical purpose that could fall within paragraph 8(d) would be the passing of the design flood.

(Slide 15) Then we move to the meaning of "necessary". And this was addressed by the Kishenganga

12:59 Court in the context of paragraph 15(iii) of Annexure D. But applying our treaty principles of reading terms in context where they are intended to have the same meaning, it would be the same meaning here. And I'm just going to read the emphasised points (PLA-3, paragraph 397):

"The Court sees no reason, for [the] purposes of the Treaty, to ascribe to it any special meaning beyond the normal use of the term to describe [an] action that is 'required, needed or essential for a particular purpose' ..."

And they emphasise (paragraph 398):

"This interpretation does not, however, reduce necessity to a mere test of what is desirable, nor does it become a self-judging matter for India alone to evaluate."

I see we have come to the top of the hour, Mr Chairman. I am very happy to stop here and continue after the lunch break.

THE CHAIRMAN: Very good.

I think we have a couple of questions for you, which you can either answer now or hold them over the lunch break and come back to us on.

Mr Minear.

MR MINEAR: Professor Webb, I noted that you have implicitly

13:00
put the burden on India with regard to making each of these showings.
PROFESSOR WEBB: Yes.
MR MINEAR: Did the Kishenganga Court place the burden on India?
PROFESSOR WEBB: I believe they did. But let me check that and come back to you after the lunch break.
MR MINEAR: Thank you.
THE CHAIRMAN: A question from me is: I'm having a little bit of trouble reconciling what I heard Sir Daniel say this morning about needing to take into account the location of the site of the dam when we're thinking through, I think, the paragraph 8 requirements.
You are approaching this issue of outlets on an assumption, I think, that the site has already been selected and we're now trying to figure out: for sediment control, do you really need an outlet below dead storage level? And that I can understand, and I think the Memorial was largely oriented towards that. What's less clear to me is how this features in a point in time before that, where you're looking at the location of the site.
And I suppose I'll connect this back to a question I had for Dr Morris. If it's the case that there would always be a site where you would not need to have

13:02
an outlet below dead storage level, then how should we be thinking about -- do we even get to the point, once we're at the site, of having to go through the analysis that you're talking about?
PROFESSOR WEBB: Let me give an initial response on that, which is: as the Kishenganga Court confirmed, the Treaty prohibits drawing down below dead storage level. And that feeds into the choice of site, because if you choose a site and choose a design where empty flushing is your so-called "only option" for maintaining live storage and protecting turbines from abrasion, then you have already put yourself in a position where you're going to have these low-level outlets below dead storage level, where you're going to have extremely large orifice spillways, and all the other design features we see in the typical Indian design that I'll be coming later in the presentation.
So I think the choice of site comes initially into that aspect of the Treaty's requirements.
THE CHAIRMAN: Right. But again, the point would just be that if it's always the case that there will be another site, where you don't even get then to the issue of needing that low-level orifice, then does it always drive you to a site where you don't actually have to then think, as you're constructing this dam: do I need

13:03
a low-level orifice?
PROFESSOR WEBB: Yes. So there are sites where you can have sluicing and other techniques for sediment management where you may still need a low-level orifice, so you may still enter the paragraph 8(d) analysis, and that may be because of the topography of the site, the geology, the seismicity. So there are other factors that may come in. And as Dr Morris flagged, and as I'll come in to show as well, there are scenarios where you may have a low-level orifice, it's not completely excluded by the Treaty, but it has to be as small as possible, it has to be as high as possible in relation to the dead storage level.
So there's scenarios beyond just the drawdown flushing where you may need some kind of low-level outlet.
THE CHAIRMAN: Yes, I think you understand what I'm driving at, and it's really trying to understand where we're drawing the line. I think what I'm hearing you saying is: it may well be the case that there are sites where a low-level orifice is going to be needed. And I'm trying to figure out: well, why isn't it at an earlier point in time that one would say, "Well, don't put it there; put it somewhere elsewhere you don't need that low-level orifice"?

13:05
PROFESSOR WEBB: Yes.
THE CHAIRMAN: So maybe you could think about that a little bit and let us know your thoughts in due course.
PROFESSOR WEBB: Yes, thank you.
THE CHAIRMAN: Okay, I think we are at the lunch break. Why don't we stop here and come back at 2 o'clock.
Thank you very much, Professor Webb.
PROFESSOR WEBB: Thank you.
(1.05 pm)
(Adjourned until 2.00 pm)
(2.02 pm)
THE CHAIRMAN: Good afternoon, everyone.
Professor Webb, we're back in your hands.
PROFESSOR WEBB: Thank you, Mr Chairman.
Just returning to the questions asked just before -- Mr Minear, on your question about what the Kishenganga Court said about the burden being on India to show that something is necessary, I have now clarified this.
The Kishenganga Court did not actually have to decide on burden, or chose not to decide on the question of burden, because it found that there was a prohibition on drawdown flushing. So it wasn't a question of rule and exception, and showing one falls within it, but they found a prohibition.
Now, of course there is a very, very narrow

14:03 exception to drawdown flushing, which is the unforeseen emergency. But India did not try to bring itself within that exception in the Kishenganga case. Actually the parties both agreed that sediment accumulation was not an unforeseen emergency. So the question of burden didn't arise.

However, I can cite an ICJ case that makes clear that when you have a treaty that talks about necessity, the burden is on the party seeking to show that a certain act or technique is necessary. And that's the Certain Iranian Assets case, which is at our Exhibit PLA-0041, and the relevant point is at paragraph 108.

MR MINEAR: I thank you.

PROFESSOR WEBB: Mr Chairman, on your question about the role of site choice, and where it comes at the different phases of a development and also within the Treaty, I would just cite to you -- as I think was cited earlier -- the Kishenganga decision on clarification or interpretation, PLA-0021, paragraph 33, which makes this point about "whether a ... site will be available as a practical matter to India for hydro-electric development" in the context of drawdown flushing.

And just building on that, I want to share a few observations on site selection.

14:04 The first is that a site for a hydroelectric power plant is not preordained: it's always going to be in comparison with a number of other sites. And given the huge investment and the time and energy that these projects involve, the party will be screening for a number of parameters in any scenario.

In the Treaty, India should be screening -- and is required to screen -- for compliance with the Treaty framework. And in particular, as I said before the break, that will be not choosing a site where it is forced into a drawdown flushing scenario.

Now, that will only exclude a very small number of sites as possibilities. It may be a site that's extremely narrow, that cannot be widened because of weak geology along the dam axis: that is one that would call for drawdown flushing, and that is a site that should not be chosen.

But whatever site is chosen is not going to be ideal: there will be different challenges facing the engineers and the operators. And it may take greater expense or greater time or greater complexity of design for India to make that site, and the way it's designed and operated to be treaty-compliant. But that is something that the Treaty envisages as well.

Just to give you a concrete example, if there were

14:06 two potential locations along a river for a plant, and one would permit the use of desanders because of the space available to build the desanders, and the other site along the same river would not permit the use of desanders and therefore require India to drawdown flush, then India is required to choose the first site under the Treaty.

But once a site is chosen, there is still the continuing relevance of the criteria that I am taking you through in paragraph 8. And as I mentioned before the break, paragraph 8(d) still envisages that India may include a low-level outlet below dead storage level for sediment control and/or other technical purpose. And those examples could include contributing to passing the design flood, for example, in conjunction with a number of other spillways. And I'll have a diagram later that shows that scenario.

THE CHAIRMAN: That's very helpful. Just to pursue it a little bit, am I hearing you to say that in the course of site selection, a party should not choose a site that artificially requires a low-level outlet?

PROFESSOR WEBB: Yes.

THE CHAIRMAN: But that standard is not the same as what we then will find in paragraph 8(d) and so on. That's a different kind of standard one is applying. That's

14:08 not quite the same thing as the "necessary for sediment control or any other technical purpose"; is that correct?

PROFESSOR WEBB: Well, it is different, but it is also related because, as Dr Morris said, India, by choosing particular sites and designing plants in a particular way, creates an artificial necessity for drawdown flushing, because it has built these dams in these particular areas and with these particular types of outlets.

So it creates a necessity, but it's not the "necessity" that we talk about under the Treaty, because there was a choice earlier, at the time of site selection -- a choice recognised by the Kishenganga Court -- that means that at that point in time, India had to choose a different site.

THE CHAIRMAN: Right. I think we're seeing this in a similar way. I'm just trying to be sure.

When you were talking about paragraph 8(d), you were making it very clear that in Pakistan's view, there is no reference here to construction, and therefore there should be no weight put on cost difficulty, things of that sort.

But in the context of a site selection process, where we're just trying to think through, "Are we

14:09
picking the site artificially to develop a low-level outlet?", it seems as though maybe in that context you would be thinking about cost issues, difficulty of construction and so on. Is that correct?

PROFESSOR WEBB: I think you're thinking more broadly at that stage. That would come into it, but you'd be thinking more broadly about: how are we going to manage sediment in this area? And how are we also going to deal with potential flood risk, seismic risk, geological issues? There's a lot of things that come in.

But when you're thinking about the sediment management issues -- which, as we've heard, is the crucial issue in the Himalayas -- what the Treaty requires, both in its specific prohibition on drawdown flushing but also in its overall object and purpose, is that India does not choose a site where it has created this necessity for low-level outlets.

THE CHAIRMAN: Very good. Thank you.

PROFESSOR WEBB: Thanks.

THE CHAIRMAN: Mr Minear.

MR MINEAR: Professor, can I just ask you: when does Pakistan have an opportunity to weigh in on India's site selection?

PROFESSOR WEBB: Can I come back to you on that?

MR MINEAR: Sure.

14:10
PROFESSOR WEBB: Because that's a good point, and it will be in the cooperation and reporting requirements, which are very detailed. But, yes.

MR MINEAR: Great. I didn't mean to interrupt your flow.

PROFESSOR WEBB: No, no, that's a good point that we'll come back to. Thank you.

(Slide 15) I'm now taking us back to the interpretation of necessity in paragraph 8(d). And there are four points to make about this interpretation following the Kishenganga partial award, of "required, needed or essential for a particular purpose".

As we've been discussing in the context of questions, it is not sufficient for India to demonstrate, by reference to a cost-benefit analysis, that a low-level outlet would be preferable: it has to be "required, needed ... essential for a particular purpose".

As we've seen, paragraph 8(d) creates a presumption against the use of low-level outlets. And as the Kishenganga Court has stated, that test of necessity is not self-judging. It is not up to India -- and this goes to the false necessity creation point -- to say that such a low-level outlet is necessary. It must consult with Pakistan and it must also be objectively necessary.

14:12
In justifying a low-level outlet under paragraph 8(d), India of course cannot breach other provisions of the Treaty, in particular the prohibition on drawdown flushing except for an unforeseen emergency.

(Slide 16) This brings me to, actually, the point about site selection in the decision on interpretation or clarification (PLA-21, paragraph 33), where the Court explains that the Court recognises:

"... the actual impact of sediment at any particular site can only be evaluated in the context of that site."

But:

"Rather than limiting the application of the Treaty's prohibition on drawdown flushing ..."

As India urged:

"... this fact goes to the question of whether a particular site will be available as a practical matter to India for hydro-electric development."

(Slide 17) Coming to the next phrase in paragraph 8(d). If an outlet is proven to be necessary below dead storage level and it is for sediment control or any other technical purpose, then there are other conditions that are triggered, which are it has to be:

"... of the minimum size, and located at the highest level consistent with sound and economical design ..."

And I'll come to "satisfactory operation".

14:13
This is again consistent with the hydro bargain. By limiting the size of the outlet, this minimises the amount of water that India can discharge on a second-by-second basis. And by limiting the depth of the outlet, making it as high as possible, the Treaty removes India's ability to control the additional water volume between the dead storage level and the outlet level.

The word "design" means the rendering of a particular feature on paper and in practice. It is a word used throughout paragraph 8, not only in the subparagraphs we're looking at but also in the chapeau, that talks about "the design of any new run-of-river plant ... [that] shall conform to the following criteria". It goes beyond a mere plan or scheme. "Design" is also active, in that it includes the "art of planning and creating in accordance with an appropriate function[]" (P-527).

"Sound and economical", also in terms of its ordinary meaning: "sound" refers to "free from any decay or defect; undamaged, unbroken; in good condition" (P-418). We can apply it to this context by saying: fit for the purpose for which it is designed. It also brings in dam safety elements, when we talk about something being "safe and sound".

14:15 "Economical" means "Characterized by or tending to economy, careful [utilization] of resources; not wasteful" (P-527); and applying to this, not disproportionately expensive given the purpose for which it has been designed.

So as a result, India can design the size and height of a low-level outlet by reference to what works in the circumstances and what is affordable in that context. It is not able to claim that so-called "best practices" entitle it to a design and placement that would maximise its utility for India, in disregard of potential damaging downstream consequences for Pakistan. And if I could recall the first step set out by the Chairman yesterday afternoon, which is exactly what we apply here: that we do not use best practices that negate a specific Treaty requirement.

So as I explained on Tuesday, India is not precluded from taking advantage of advances in technology and engineering practice. We say actually paragraph 8(d) requires India to improve its design, as long as it remains within the bounds of the Treaty.

To just draw on an example that you were discussing with Dr Morris earlier, and in the exchange with Dr Blackmore, tunnel boring machines are an example of such technology, where really since the 1980s we've seen

14:16 rapid improvements in the size, cost and speed of these machines that allow long tunnels to be bored through the mountains.

(Slide 18) So finally, 8(d) requires "satisfactory operation of the works". "Operation", the ordinary meaning is "The condition of functioning or being active" (P-418). Applied to this context, it is the way in which the HEP functions once construction has been concluded and it has come online. And "satisfactory" means "sufficient" or "adequate" (P-418); not optimal, necessarily.

Paragraph 8(d) applies the same standards to the operation of a low-level outlet as to its design. So India is entitled to a low-level outlet that performs its designed function in an acceptable manner.

As I've already shown in the introduction, unlike paragraphs (e) and (f), paragraph 8(d) does not allow a low-level outlet to be justified by reference to construction, and we say that India cannot rely on construction considerations to justify a lower or larger outlet. So outlets below dead storage level, whether they are intakes or spillways or another type of outlet, are much harder to justify than outlets above dead storage level.

So that brings me -- after your question!

14:18 THE CHAIRMAN: Thank you, Professor Webb. Just because you may be moving on from 8(d).
PROFESSOR WEBB: I'm not, but ...
THE CHAIRMAN: Okay. Well, the question may still be timely.
PROFESSOR WEBB: Yes.
THE CHAIRMAN: I'm wondering: how this does relate to something like an intake? As I understand it, an intake typically needs to be located, at least partially, if not fully, below dead storage level.
So one possibility is that you view that as necessary for a technical purpose, and therefore it's outside the scope of this provision. Another possibility is that outlets that are only partially below dead storage level aren't actually covered here by 8(d).
So I was wondering if you could just clarify that for me.
PROFESSOR WEBB: Yes. Yes. Let me just come to the wording.
So you're right -- and I will come to this more when I turn to intakes -- that in most scenarios, they should be at least partially below the dead storage level. And as Dr Morris explained, there's this sort of delicate balance to be struck between being deep enough to avoid

14:19 vortexing, but also high enough to help with sediment control and not to be subject to too much sediment accumulation, although there are other techniques for dealing with that.
So they will be within 8(f), obviously; and if they are fully submerged, they will be within 8(d) as well.
THE CHAIRMAN: So a partially submerged outlet is not in 8(d); is that what you're saying?
PROFESSOR WEBB: I think that is what I am saying, yes. I may clarify that when I come to deal with 8(f). Thank you.
THE CHAIRMAN: Thank you.
PROFESSOR WEBB: So the reason we're still on 8(d) is that I now turn to the Court's question of 20 June, which is to set out as precisely as possible India's approach to the interpretation of this provision.
A constant theme in India's approach has already been referred to by Sir Daniel and Mr Fietta, and this actually applies across these provisions, which is that the terms of "sound and economical design", "satisfactory operation", the "customary and accepted practice", according to India, are a gateway for incorporating so-called "best practices" and "state-of-the-art".
Now, Pakistan doesn't believe that these are always

14:21 actually best practices or state of the art. As we said, we welcome such innovations as long as they're compatible with the Treaty. But this language is used by India to look to practices and sources external to the Treaty.

So as a result, India's designs tend to include fully submerged orifice spillways entirely below the dead storage level, and India claims that these are necessary for sediment management and flood control, and are to be sized for the flood control function. So this implicates both 8(d) that we are talking about now, but also 8(e), when we come specifically to spillways.

(Slide 19) This is a picture of the typical Indian design. This is from our Memorial, figure 10.11. It is the proposed spillway design for the Baglihar HEP, which, as we've set out, has been replicated in multiple designs across the Western Rivers.

Now, as Dr Morris explained, the use of an orifice spillway for flood control and sediment management can comply with the Treaty, but only if India proves that it meets the requirements of both 8(d) and 8(e). And one sort of bright line, or red line, is that India must not use the multi-use orifice spillway to empty the reservoir below the dead storage level. So it could use a multi-use orifice spillway to undertake sluicing at

14:23 the dead storage level, but not as a form of sediment management that depletes the water below the dead storage level.

I really can't say it better than as Dr Morris explained it this morning in relation to his slide 17, which is: when you look at a spillway, the gate capacity below the dead storage level is the flow that you need for sediment management. And as he explained, that's a 5-10-year flood. Whereas the gate capacity above the dead storage level is to pass the design flood. And that's how those gates should be designed to fulfil the criteria of minimum size and highest level.

And actually the ICOLD guidelines -- and I'll cite Bulletin 115, Exhibit P-0530, at pages 79 and 81 -- indicate that flushing for outlet capacity should be capable of passing a 5-year flood, not the 10,000-year event. And this has very significant implications for design.

So if we take the Baglihar HEP, a 5-year flood at Baglihar is estimated to be 4,250 cumecs. The PMF, which is defined as the 10,000-year flood at Baglihar, is 16,500 cumecs, and that's what they have designed for.

So Pakistan and India have exchanged on this specific issue within the Commission. So through these

14:25 exchanges, we get an even greater insight into what India's case is here.

(Slide 20) Pakistan's Commissioner raised this issue of how the low-level outlets were being designed in the 111th meeting of the Commission. And I'll just read out the first paragraph (P-25, paragraph 29):

"PCIW said that despite the fact that clear guidelines are provided regarding sediment management in Baglihar and Kishenganga cases yet India keeps on proposing deep orifice spillways in its designs. The [Kishenganga Court] has imposed a restriction upon India that it will not draw the water level down below [Dead Storage Level] for flushing and India has given assurance to abide by the Award of the Court. PCIW further stated that Pakistan does not have any objections to sluicing but is of the view that once drawdown flushing is ruled out, crest-gated spillways can effectively pass the sediments through the reservoir."

Those spillways being above the dead storage level.

(Slide 21) India responded in the same meeting (P-25, paragraph 33):

"Neither the Treaty nor the Court has imposed any restriction on placement of orifice[s]. There has not been any literature which substantiates Pakistan

14:26 side[']s view that orifice spillway can only be provided for drawdown flushing and not for sluicing. The restriction imposed by [the Kishenganga Court] is operational and India has given unequivocal assurance to abide by the same. India has right to manage the sediments within the means available and there is no provision in the Treaty which states orifice spillway cannot be provided by India. [The Kishenganga Court] has duly considered the orifice spillway configuration provided by India and has not objected to the same. India has adopted techno-economically sound design as per Treaty provisions duly considering all technical requirements including sluicing."

Now I'll explain why India's position as expressed here, and which we believe remains their consistent position, is wrong.

Pakistan's position is not based on what India calls "engineering literature" showing that an orifice spillway cannot be used for sluicing. It is based on the terms of paragraph 8(d), which precludes the use of low-level outlets for sediment management "unless necessary". Where sluicing is sufficient for sediment management, and can be accomplished by a crest-gated spillway above dead storage level, a deep orifice spillway, unless otherwise required to pass the design

14:27 flood, is not necessary, and its inclusion in an Annexure D.3 plant will breach paragraph 8(d).

The second problem with this statement is that the Kishenganga Court did not directly consider compliance of the deep orifice spillway design at Kishenganga with paragraph 8(d) because the question wasn't before it. But under the second dispute before that Court, it considered whether drawdown flushing was prohibited under the Treaty, and concluded, as a systemic interpretation, that it was prohibited. And as you heard from Dr Morris, the Court would have felt comfortable with that outcome, since there are always options alternative to drawdown flushing if you haven't chosen a site that completely precludes other options.

While the restriction on drawdown flushing identified by the Kishenganga Court is operational in character, that doesn't prevent it from limiting India's design options. Here you see India arguing that this is purely an operational point. The Kishenganga Court clearly drew the connection between design and operation when it said -- and this is at paragraph 506 of the partial award (PLA-3) -- that:

"... in many instances the Treaty does not simply restrict the Parties from taking certain actions ..."

Operational:

14:29 "... but also constrains their entitlement to construct works that would enable such actions to be taken."

Which is the design aspect.

(Slide 22) So the Kishenganga partial award stated (paragraph 522) that:

"In the case of [Kishenganga], the Court is cognizant that changes to the design of the project may be required to optimize the management of sediment in light of this partial award."

In light of the prohibition on drawdown flushing. And that was the expectation that just because it's difficult or costly or time-consuming doesn't mean that it is taken outside of the Treaty requirements.

I'm going to address the approach of the Neutral Expert in Baglihar in more detail in the context of paragraph 8(e) on spillways, but for the moment I note that the Neutral Expert stated that paragraph 8(d) was the controlling provision for determining whether India was allowed to site its orifice spillway below the dead storage level. But his analysis was flawed by his finding that depletion below dead storage level was permissible under the Treaty for sediment management, a position that the Kishenganga Court later, and rightly, rejected. And this flaw in the Neutral

14:30 Expert's reasoning in Baglihar led him to approving the design of an orifice spillway in which the bottom level of the gates in Baglihar is located 27 metres below the dead storage level.

(Slide 23) So I conclude this part on 8(d) by returning to your question in Procedural Order No. 6 at paragraph 35(e), where the Court asked:

"... what is to be taken into account for the purposes of designing low-level sediment outlets for a plant and what is to be excluded?"

(Slide 24) And let me emphasise that what we see here is not a tick-box exercise because, as we've already discussed, there's levels of decision-making and compliance with the Treaty that start even at the choice of the site. But this is, in response to the Court's questions, some factors that will be relevant -- not necessarily an exhaustive list -- and factors that will be irrelevant.

So looking at whether a low-level outlet is required, and then is designed in the proper way, it is relevant to look at the necessity for sediment control; the necessity for another technical purpose, which would be, we say, the design flood; the need for that sediment control to be within the Treaty limits; and then from more of a design perspective, it is relevant to look at

14:32 the position of that outlet relative to other structures and other requirements for structural and hydromechanical design.

It is irrelevant for India to look to an ancillary non-technical benefit that might be social, economic, environmental: irrigation, for example. It's irrelevant to look at objectives separate to sediment management or the design flood. And it is irrelevant, under 8(d), to look to construction. It doesn't matter if it's easier or cheaper for India to build a low-level outlet rather than a higher one in the reservoir.

(Slide 25) So now turning to paragraph 8(e) and spillways.

As you know, a spillway is a large outlet principally designed to pass floodwater downstream and prevent unsafe overtopping of the dam. You saw this image during the site visit: this is the crest-gated spillway at Tarbela Dam.

Now, the site expert on the visit explained that although the principal function of a spillway is to manage flood conditions, the additional control granted to the operator by a controlled spillway means that it can also be used for other purposes, such as water level control, and that could be important for things like sluicing.

14:34 Dr Morris explained that a spillway's capacity will usually depend on the design flood. The design may allow for some damage during extreme floods, but it is expected to be able to discharge smaller floods without any damage.

(Slide 26) Another slide that you've seen during the site visit and during these proceedings, and I'm sure you will see again during the freeboard presentation.

The Court asked during the site visit:

"What are the range of circumstances where a gated spillway might be beneficial or required for a run-of-river HEP on the Western Rivers ...?"

(Slide 27) And this was answered during the site visit, during presentation 6, and this is the slide that was shown in response to your question and the different spillway configurations. And just to recap them for the context of paragraph 8(e).

So the left image is the most basic spillway design: a surface or ungated spillway. It is recommended by default by many engineering standards, due to its simplicity. The discharge rate from such spillways is the function of the height of the reservoir level over the spillway crest, and flood discharge requires that the reservoir level and the storage experience a surcharge above the full pondage level.

14:35 Now, the middle and the right-hand images are both of gated spillways, the middle one being a crest-gated spillway, like you saw at Tarbela, and the one on the right being an orifice spillway. These use large mechanical gates to control the discharge of water, and they may be located at any level within the reservoir. Crest-gated spillways tend to be at the top of the dam wall or an adjacent abutment. Orifice spillways are located within the dam and are fully submerged. Because the gates are mechanical, they may remain stuck in a closed position during a flood, due to mechanical failure, operator error or debris blockage.

(Slide 28) So we can look at these spillways from another angle, and this is another slide you saw during the site visit.

So this time looking at the ungated surface spillway on the left, we can see that the discharge capacity is fixed by the length of the spillway, and the maximum width is going to be a function of the width of the valley, which comes back to the topographical and geological constraints that any hydropower plant will face.

In the middle, we have the gated surface spillway that allows water to be stored and controlled in a zone otherwise than for flood surcharge.

14:36 If the valley is not wide enough for a crest-gated spillway to pass the design flood, then the dam designer may provide for orifice spillways, as illustrated in the right image.

Now, the deep outlet operates under higher water pressure, enabling the discharge capacity of a crest spillway to be obtained with a smaller orifice. And you can see in the cross-section that the orifice spillway has a fixed size, it doesn't have any space above it, obviously being in the dam wall, and its capacity to increase the flow rate under a flood surcharge condition is therefore also limited.

By contrast, when you look at the surface spillway, you can see that the area of flow will increase as the flow depth increases over the spillway crest. So the increasing area of water flow will provide much more excess capacity in an ungated spillway as compared to an orifice discharge. So the crest-gated spillway in the middle will be more capable of passing larger than design floods.

But as I said in response to your question earlier, and as Dr Morris has also explained, an orifice spillway may still, depending on the plant and the conditions, serve a purpose when you have an area where it limits the width of the spillway that you can use. And

14:38 situating the orifice spillway in the middle, rather than at the crest, can also potentially reduce construction costs; which are, of course, not relevant to 8(d).

Having said that, orifice spillways in and of themselves are not without their drawbacks. The increased velocity and density of the water jet that exits the spillway can erode the riverbed at the foot of the dam more than the other spillway designs; and it also, from a construction point of view, has to deal with that greater water pressure.

During the site visit, the site expert who showed you these slides explained that a plant would not typically have just an orifice spillway, what we see on the right-hand side; it would usually be combined with other designs.

(Slide 29) And you saw this image as well, which is Karun-3 Dam in Iran, where it's an example of the inclusion of multiple spillways. So, for instance, the risk of gate failure that you could get with the crest-gated spillway or the orifice spillway is mitigated by including an ungated spillway for which gate failure would not be an issue.

At Neelum-Jhelum, you also saw the use of multiple spillways at different elevations performing different

14:40 functions. That project, not being a Treaty project, incorporates orifice and surface gated spillways, together with undersluices that are in the intake structure for sediment management.

So in a non-Treaty plant like Neelum-Jhelum, the design will take into account the flood conditions, the topographical conditions, geological conditions and the dam site layout. Once we come within the Treaty, there will be additional constraints.

That takes me -- oh, that's a surface gated spillway you saw there as well (slide 31).

(Slide 32) That takes me to the provision that specifically focuses on spillways in the Treaty, 8(e).

According to this paragraph, we also have a default condition. So the default condition in 8(d) is no low-level outlet; the default condition in 8(e) is to use an ungated spillway. But if the conditions at the site make it necessary, then a gated spillway is permitted, but this then, of course, has to comply with other conditions: being "at the highest level", compliant with "sound and economical design", and this time "satisfactory construction and operation of the works".

(Slide 33) So we can see here the equivalent flowchart for the decision-making process under

14:41 paragraph 8(e).

The default position is an ungated spillway.

If it is shown that a gated spillway is necessary, then it will come into the second phase of looking at the various options compliant with sound and economical design.

In selecting among those various options, we once again come to the object and purpose of the Treaty, to the hydro bargain and protecting the hydrology of Pakistan on the Western Rivers. So if it is possible that there can be even a marginally higher spillway, then that design is to be preferred over another one.

And then finally we come to "satisfactory construction and operation of the works": once again, "satisfactory" meaning "acceptable", "suitable", but not more than that.

So if you have a spillway that is entirely below dead storage level -- and actually I return to the question of Mr Chairman, and this applies equally to intakes: it is if it is entirely below that it would require reference to 8(d).

(SLIDE 34) But imagining that we are not entirely below the dead storage level, then the analysis would follow through paragraph 8(e). And the first condition is that:

14:43 "... the conditions at the site of a Plant make a gated spillway necessary ..."

"Necessary" of course here, applying treaty interpretation principles, has the same meaning as it does in 8(d): essential for the purpose required and needed. It is to be determined objectively, it's not self-judging, and the burden is on India to discharge that.

Now, necessity here is clarified as being a reference to "conditions at the site". And a relevant site condition is one that is related to the acceptable purposes of a spillway and relevant factors of the design. And I'll highlight three relevant conditions at the site.

(Slide 35) So the first is flood control, especially control of the design flood as a relevant condition at the site. And we can turn here to ICOLD Bulletin 178 (P-529), which emphasises that:

"Simplicity of design and construction is conducive to simpler [operation], and simple rules which can be implemented quickly are ... obviously a determining factor [for] safety. This means that an ungated free-overflow spillway is the ideal solution which all dam operators would prefer."

So in paragraph 8(e), by having the default position

14:44 being an ungated surface free-overflow spillway, that's actually where the Treaty is aligned with best practice.

Now, the type of dam is also relevant to flood control. An ungated spillway is the preferred design for an erodible rock-filled or embankment dam because they are at a higher risk of failure if they are overtopped, and it would be the safest option to avoid potential mechanical or operator problems with the gates.

(Slide 36) Just to illustrate that point, last year, in October, the 16-metre-high concrete-faced rockfill dam of the 1,200 MW Teesta Stage III HEP in India was breached by floodwaters. The dam was overtopped and failed catastrophically. This was attributed by the Indian experts to the spillway not being designed to accommodate a high flow due to a GLOF. And there was also no functional early warning system.

The powerhouse was submerged; the bridge connecting the powerhouse was washed away; roads, bridges and towns were flooded; and more than 100 people died.

That gated spillway was designed to handle a maximum flood of 7,000 cusecs, which is now found not to be sufficient. And the spillway gates were not opened due to the inability of the operators to reach the controls due to the overtopping.

14:46 (Slide 37) So the second factor for conditions at the site is geology and topology. And it could be that India departs from the default ungated spillway position if the site of the plant is not suitable for an uncontrolled spillway. And this is a photo of a typically narrow-valley dam, which is the Aldeadávila Dam in Spain. You've got eight gates channelling water into four spillways.

Now, if the valley is not sufficiently wide to accommodate an uncontrolled spillway capable of passing the design flood without overtopping, then that's an example of it being necessary to have a gated spillway. Another scenario is where the geology of the valley means it can't be widened to accommodate an uncontrolled spillway capable of passing the design flow.

(Slide 38) A third site condition is sedimentation, of course. If the sedimentation analysis at a site reveals that sluicing is necessary to maintain live storage or prevent sediment from entering the turbines, then a gated spillway may be necessary to enable sluicing to occur. And according to ICOLD Bulletin 115, once the design discharge and stage at the dam is known, it is possible to design controlled outlets with sufficient discharge capacity for sluicing.

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14:48 Of course, where other sediment management techniques are sufficient to achieve sediment control, this option of sluicing using a gated spillway would not be necessary.

(Slide 39) Finally, the phrase "conditions at the site" in 8(e) cannot encompass cost. Cost may be a consequence of the site conditions, but it is not a site condition in and of itself.

As Dr Morris has pointed out, dam engineering doesn't happen in a void: it's always within a set of constraints. In this case, the constraints include the Treaty provisions.

(Slide 40) If a gated spillway has been justified as necessary, it has to still comply with design requirements of paragraph 8(e), and this may lead to variations in the type of gate that is chosen.

So paragraph 8(e) favours a wide crest-gated spillway with comparatively shallow gates over a narrow crest-gated spillway with comparatively deep gates, because the first type is going to be higher. And India would have to provide further justification for a fully submerged orifice spillway.

(Slide 41) We come back to the phrase "sound and economical design", and it should be read identically as it appears in 8(d). It refers to a design that's fit

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14:50 for purpose, not unfeasibly expensive. It does not entitle India to claim its design reflects the best practices of the day in a manner detached from the Treaty requirements.

But there are best practices that are compatible with the Treaty requirements. One example is to use a plant surcharge storage, which of course it has to design for under 8(b), to situate an ungated auxiliary spillway for extreme flood conditions, therefore enabling the main spillway gates to be smaller and higher. So that's an example of an engineering innovation that we can apply that actually helps to fulfil the conditions in paragraph 8(e).

"Satisfactory construction and operation of the works". As I said earlier, "satisfactory" means sufficient or adequate. Construction considerations are relevant to the extent of being adequate and sufficient. Where this threshold is met by a crest-gated spillway, India is not entitled to situate its spillway deeper in the reservoir because of any perceived operational advantage derived from an orifice spillway.

So in reality, this means that circumstances in which an orifice spillway will be justifiable will be pretty rare; not completely excluded, but unusual. In nearly all cases, a crest-gated spillway will do the job

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14:51 of an orifice spillway just as well, or only marginally less well, from a purely hydraulic or construction cost standpoint.

The crest-gated spillway also has the advantage of offering a greater increase in discharge capacity beyond the design value, as water level surcharges above the design level, as compared to the orifice spillway, which is limited by its fixed cross-sectional area.

It may also be considered that a crest-gated spillway is more effective in preventing India from utilising freeboard for water storage.

So the selection of a crest-gated spillway is a potentially viable option under 8(e), if it is shown that an ungated spillway is not possible.

So I now turn to how India has approached this paragraph. Pakistan's understanding of India's current interpretation is informed by the pleadings of India in the Baglihar and Kishenganga proceedings, and also the exchanges in the Commission, as I showed for 8(d).

(Slide 42) Now, I've shown you this typical design before. Now we're looking at the orifice spillways, so they are submerged entirely below the dead storage level, and India claims that they are necessary for sediment management and flood control.

In the 103rd meeting of the Commission (P-66),

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14:53 India's Commissioner stated that an orifice spillway was "consistent with the state-of-the-art practices", and referred to it as:

"... a trend that has been growing ... of setting the top of the gate well below [the dead storage level] & surmounting it by a massive reinforced concrete water retaining wall ..."

(Slide 43) In the 111th meeting (P-25), India attempted to justify its use of orifice spillways in the Commission. I previously showed this to you in the context of 8(d), because they had to be read together, given that this was entirely below the dead storage level. And I explained to you how this statement was wrong with respect to the interpretation of 8(d). I now will explain how it is inconsistent with the correct interpretation of paragraph 8(e).

India must justify any departure from the default position of paragraph 8(e) that it is entitled to an ungated spillway. While sediment management and the role of the gated spillway in sluicing may factor into determining whether a departure from that default position is required, the Treaty poses a clear restriction on the use of a gated spillway by reference to the conditions at the site.

Pakistan's position, despite what the Indian

14:55 Commissioner speculated, was not based on engineering literature: it was based on the limitations of paragraph 8(e), including that crest-gated spillways are designed for very large discharges, with the capacity determined by the height and width of the gate. Precedents for orifice and crest-gated spillway-gated spillways can be referenced to determine limits, but the majority of dam sites can be configured with crest-gated spillways.

The Kishenganga Court did not directly assess compliance with the deep orifice spillway design of the KHEP because, as I said before, the question wasn't before it. But the restrictions that are identified, in particular on drawdown flushing, obviously influence the design choices, including for the use of a fully submerged orifice spillway.

(Slide 44) I want to now turn to what the Neutral Expert said in Baglihar. These were the competing designs that the Neutral Expert was facing. The one on the left I've already shown you: this is the Indian design. The one on the right was Pakistan's design.

So we see in the Indian design that we have three separate spillways: a submerged orifice spillway with five gates; a crest-gated spillway with three gates; and a single auxiliary spillway. Pakistan's design has

14:56 a single ungated spillway.

(Slide 45) Now, the Neutral Expert first analysed whether a gated spillway was "necessary" within the meaning of 8(e). And in this respect only, he correctly commenced the analysis with an examination of the conditions at the Baglihar site. So he said the following (PLA-2, paragraph 5.2.4), that:

"The determination of the possible arrangement of spillways must be driven by the general conditions of the site, which can be classified into ... four categories:

- hydrology and sediment yield,
- topography,
- geology, and
- seismicity."

So Pakistan, to that extent, would agree that these are the correct identification of site conditions. Not an exhaustive list, but these are actually site conditions.

In the case of the Baglihar plant, it is built in a narrow valley, 70 metres at the river elevation, 300 metres at the dam crest elevation, and it has a high flood discharge, high seismic activity and poor geology, and with that reducing the ability to do anything to widen the valley.

14:58 The valley has an insufficient width for an ungated spillway to handle the design flood; and it cannot, as I said, be safely widened, due to the weakness of its geology. But even with the possibility of human and mechanical error involved in having a gated spillway, it may still have been necessary in that case: it might have passed the "necessary" test.

But for the avoidance of doubt, Pakistan does not concede that a gated spillway was necessary for the Baglihar plant, but notes that this element of the Neutral Expert's analysis, at least in this respect, was defensible under 8(e). He was looking at the right conditions to determine necessity driven by site conditions.

(Slide 46) But from that point onwards, the Neutral Expert took a wrong turn in Baglihar. He took into account the costs of a gated versus ungated spillway, which are not conditions at the site and therefore irrelevant for determining necessity. He said (PLA-2, paragraph 5.2.4):

"... for a given level of safety and taking into account site conditions, the economics of the project lead to the selection of the optimum arrangement of ... spillway devices."

He discussed the maximisation of production, so

14:59 that's using the maximum available head, and he talked about the minimisation of construction costs. When you build an ungated spillway, it usually means the dam height has to be higher, so there's the additional cost of concrete and the construction.

He also reviewed projects in Uganda, The Gambia, Sudan and Portugal where they had used large orifice spillways.

He concluded (PLA-2, paragraph 5.28) that:

"... it has been demonstrated that the provision of gates on large spillways is a frequent practice ..."

And:

"... the sole use of an ungated free-overflow spillway is marginal when the required capacity for flood releases is higher than 15,000 [cumecs]."

But this approach is not the approach that the Treaty requires.

The comparison with dams in Uganda, Sudan, Gambia and Portugal does not demonstrate that the use of a gated spillway in a run-of-river HEP under the Treaty is "necessary". It simply shows that such spillways are preferred by designers when they are given a free hand and when they're dealing with completely different site conditions.

And second, all of the relevant plants in Uganda and

15:01 so on would have been constructed with the economic considerations in mind that are irrelevant to the test of necessity under paragraph (e).

So paragraph 8, as we've said, does not preclude evidence of hydroengineering practice being used to inform the application of provisions. If India was to present evidence of a Nepalese run-of-river HEP in similar conditions to the Baglihar HEP that suffered catastrophic damage due to the lack of a gated spillway, that would be highly relevant to determining whether a gated spillway was "necessary" under paragraph 8(e). But all of this has to be brought in as relevant and assessed carefully under the Treaty.

(Slide 47) Now I come to Procedural Order No. 6 and your question on:

"... what is to be taken into account for the purposes of designing gated spillways for flood control for a plant and what is to be excluded?"

(Slide 48) And once again, this is a non-exhaustive list. But what will be relevant are the conditions at the immediate site of the plant: the valley width, the geology, seismicity, hydrography, of course sedimentation. Whether a gated spillway, given these conditions is necessary; not cheaper, not more convenient, not preferable, but necessary. And when it

15:02 comes to reaching a satisfactory standard, that's when you can look at the economics of it.

What is not relevant are: factors that are not at the site, they are not going to be site conditions; economic and cost considerations for the test of necessity; and a wider situation away from the HEP site, whether that's upstream or downstream.

So the application of paragraphs 8(e) and (d) to the different designs can be illustrated by the following slide (49). This reflects a scenario where a gated spillway is necessary due to conditions at the site.

Starting from the left, you have a crest-gated spillway sized for the probable maximum flood. And this would comply with the Treaty because the bottom level of the gates in the normal closed position are located at the highest level consistent with sound and economical design, and satisfactory construction and operation of the works. They are designed to provide the required discharge capacity. And the sill level of the gates would allow for sediment sluicing, as well as being located below the possible level of the power intake.

So that, despite being a gated spillway, would, once the necessity is shown, comply with 8(e).

The second design combines different spillway designs. It has gated spillways at the highest possible

15:04 level above dead storage level, and two smaller orifice spillways that are below dead storage level, of the minimum size and the highest level, and that's why they are relatively small compared to what we saw with the crest-gated spillway.

But the third image, just the large orifice spillway, would not comply with 8(e). They are not at the highest level and they are not of the minimum size required for sediment management or another technical purpose, and there are alternatives available that could be located at a higher level.

Depending on the site, this is possibly the range of options that India would have for designing its spillways. And the preferable -- indeed, required -- design would be the crest-gated spillway on the left or the combination of the crest and orifice spillways, if those orifice spillways complied with 8(d).

I'm now, unless there are questions on spillways, going to move to intakes. Okay.

So a power intake is a structure through which the water is abstracted from the reservoir to the turbines via a pipe, tunnel or canal. It, as I said at the beginning, has a dual function, in that it's an intake for the turbines but it's an outlet for the reservoir.

(Slide 50) Now, during the site visit you saw this

15:06 slide, which is a cross-section of the intake at Neelum-Jhelum going into the desander. There are six intake gates and three undersluice gates, and the intakes are used to divert water for power production.

Now -- and this was a point flagged by Mr Chairman earlier -- intakes have to be situated to take advantage of the full range of the live storage at the plant in the operating pool. So the bottom level of the intake must be placed below the minimum operating level and below the dead storage level in an Annexure D.3 HEP to enable the design flow rate to enter the intake when the reservoir's water level is at its minimum operating level; that is, DSL. This will convert all water above the invert of the intake into controllable storage, just as with the case of the height of the crest elevation of the outlet.

But that still leaves a range of design options as to how that intake is placed, and what other features may be placed around it to enhance its functioning and enable its highest position.

(Slide 51) So this shows two potential power intake configurations in a run-of-river HEP.

On the right, we have a surface-level intake in which the water is flowing from the reservoir into the intake. It's continuously open to the atmosphere; it's

15:07 not submerged. And it may include a structure which limits withdrawals to the highest extent to minimise the entry of sediment. And that then flows into the tunnel.

So you see -- and this is similar to a slide that Dr Morris showed you -- you see how it goes from a higher level at the surface intake and then into the tunnel, with an anti-vortex water seal depth taken into account.

On the left, we see a submerged or a deep intake, and this is what India's plant designs include. This results in all the water above the intake's invert being converted into controllable storage. So the tunnel leading to the turbines terminates directly in the reservoir, without any structure excluding sediment. And this configuration, as Dr Morris also said, you would usually see in a storage work, but we are seeing it in India's replicated run-of-river HEP designs.

Since it's below dead storage level, this kind of deep intake is also subject to regulation under 8(d). The one on the right would not be.

THE CHAIRMAN: Does Annexure E allow that type of intake for the storage works?

PROFESSOR WEBB: According to paragraph 11(g) of Annexure E:

"... the intakes ... shall be located at the highest level consistent with satisfactory and economical

15:09 construction, operation of the plant and ... customary and accepted practice ..."

So it's the same wording as we're seeing in 8(f).

Now, there may be different considerations influencing what is "sound and economical" and what is "satisfactory" in a storage work as compared to a run-of-river plant. But there's still the reflection of the hydro bargain in trying to minimise the controllable storage, even in a storage plant.

THE CHAIRMAN: I was just wondering -- we really haven't talked about Annexure E that much. But is it the case that a typical operation would allow for you to draw down the storage perhaps quite far in order to do things with it, not just for hydro purposes?

PROFESSOR WEBB: Irrigation and so on?

THE CHAIRMAN: Yes.

PROFESSOR WEBB: I will have to consult with my engineering experts to firmly answer that for you.

THE CHAIRMAN: That's fine.

PROFESSOR WEBB: But certainly there are other considerations at stake. But even with that, we are seeing a preference for the highest type of intake, even in a storage work.

(Slide 52) Now, we also saw this slide during the site, which just shows how the water is abstracted from

15:11 the reservoir via the headrace, which we know is pressurised.

The fact that an intake is a surface intake does not prevent the incorporation of a pressurised headrace complete with a water seal. So the design at the surface can absolutely and does work, as we saw, through this type of conveyance mechanisms.

There are three important considerations during the plant planning process to consider with intake design. The first is the minimum operating level of the reservoir: that sets the benchmark for the placement of the intakes. The second is the need to minimise sediment entering the intakes, because of course we know that's going to go directly into the turbine and abrade it. And there's also the need to prevent or minimise air entering the intakes through vortexing, which will result in the loss of power.

(Slide 53) Now, during the site visit we showed you this slide, which is an example of poor intake design. This is Pakistan's Warsak Dam. And as the site expert explained to you, this dam was built in 1960 with 14-metre-deep intakes and no effective way to manage sediment, and it's now submerged deep beneath the sand.

(Slide 54) As the site expert explained using this cross-section, the intake has been buried up to the spillway crest. So what you see there that's not even visible, the 14-metre-deep intake, on this cross-section is at the spillway crest level, between 1,200 and 1,250 feet.

It has been possible to maintain power production by passing more water through the turbines. But this is obviously an example of poor design.

I come back to the Court's question 3 during the site visit.

"What are the range of circumstances where it might be either beneficial or required to locate, at a relatively low level, the power intake for the turbines of a run-of-river HEP on the Western Rivers ...?"

The response that I recall being given to you was listing the circumstances for a generic plant, where a lower-level intake may be beneficial or not beneficial. So these obviously have to then be overlaid by the Treaty's regulatory requirements.

The site expert explained that a deeper intake -- oh, and let me give you the references: transcript Day 4, page 111 -- a deeper intake is beneficial for minimising the entry of floating debris. This benefit is actually marginal because much of the debris in the rivers in this area floats below the water surface; it's

not actually on the surface, such as the plastic trash that we saw during the site visit. So that's a benefit of a deeper intake: it will minimise the entry of that floating debris, or neutrally buoyant debris.

On the other hand, a deeper intake will bring in more sediment. Sediment concentration tends to increase with depth; this is shown in a sediment concentration gradient. The sands, which are the ones that are most dangerous for turbine abrasion, tend to be concentrated near the bottom of the water column, rather than the top. So this means a sample collected at the water surface will not be representative of a cross-section. But it also means that, in the Himalayas, sediment control for turbine protection is better achieved by putting intakes higher, where there is less concentration of sand.

A higher level intake has the risks of vortices forming, which may bring in air and reduce turbine efficiency. But as I said, it's a delicate balance: you want to avoid the sediment entry and you want to avoid the vortices forming, and that pushes you in two different directions. But once you reach the minimum depth to control vortex formation, going any lower is not going to be of any benefit in terms of vortexing.

This is confirmed by the hydroengineering

literature, and this is from Gordon at Exhibit P-0312:

"For a conventional hydroelectric intake, with a deck slab ... above water level, the cost of the intake structure increases with increasing depth of gate sill below water level. For maximum economy the gate sill should be set as high as possible."

And the depth needed to prevent vortices forming can be reduced by hydraulic design of the intake arrangement. So you could have a broad and shallow inlet to the tunnel: that will require less submergence than a narrow and deep inlet. So these are all creative and very available engineering techniques that can allow the raising of the intake to manage that vortex formation.

A deeper intake is also harder to clean and maintain, and it has to operate at higher pressure and have more robust gates.

So in the run-of-river HEPs that you see in the Himalayas, you actually see intakes -- not in the Indian plants, but in the other plants -- situated as high as possible in the reservoir, while still allowing for the live storage to be used in its entirety.

(Slide 55) Let's now overlay this with the Treaty requirements, and this is paragraph 8(f). By requiring that the power intakes are placed as high as possible

within the reservoir, it limits the extent to which they can be used to manipulate controllable storage; once again, consistent that we see with the other provisions, and with the object and purpose of the Treaty.

But even outside of a Treaty context, higher intakes are the preferred design choice for run-of-river plants.

(Slide 56) This time we have a three-step instead of a four-step process for applying paragraph 8(f), because we don't start with a default option. So we don't have the default of no low-level outlets and we don't have the default of a surface spillway. Instead, we start by identifying the options for that intake design. And you're guided there by the requirements of it being satisfactory and economical.

Once those options are identified, India is obliged to choose the design that best protects Pakistan's hydrology, Pakistan's interests on the Western Rivers, meaning the highest level intake possible in the reservoir. If there's a choice in design, and one is higher, then the higher one has to be chosen, even if it is more expensive.

And the third step is that the intake design shall be consistent with customary and accepted practice of design for the designated range of a HEP's operation; that means the range between the full pondage level and

15:19 the dead storage level.

(Slide 57) Now, taking these in turn, these opening words are very clear, that it has to be:

"... at the highest level consistent with satisfactory and economical construction and operation ..."

But as we've already accepted, owing to the need for power intakes to use the full range of the operating pool, there will be a part that is below dead storage level.

(Slide 58) They have to be "satisfactory and economical"; and importantly, in the context of the operation of the plant as a run-of-river plant. And this specification is deliberate because of the specific issues that run-of-river plants face, as opposed to other types.

(Slide 59) I actually do have the matching wording in Annexure E here, 11(g) that I read out earlier, which also talks about being:

"... located at the highest level, consistent with satisfactory and economical construction and operation ..."

Given that the principal difficulty for run-of-river HEPs is sediment control, this can be managed by various techniques, as we've heard. And a well-designed

15:20 surface-level intake can be one of those techniques, complemented by a desander, as we saw at Neelum-Jhelum, and enhanced by a skimming wall, for example.

(Slide 60) Now we come to language that only appears in 8(f), compared to (d) and (e), which is the:

"... customary and accepted practice of design for the designated range of the Plant's operation."

Let me start with "designated range of the Plant's operation". Applied to the context of this paragraph, that is the varying levels of water in the reservoir, so between the full pondage level and the dead storage level.

(Slide 61) Then we come to "customary and accepted practice of design". And this recalls, I think, some comments made this week by Mr Minear and by the Chairman pointing out this language.

Going back to Mr Minear's point -- I think that was made on Tuesday -- he rightly pointed out that this language appears in Article IV(12)(a) of the Treaty, which refers to the use of water for industrial purposes, and it talks about customary and accepted practice as of the "Effective Date", which was 1 April 1960.

That is not an evolving provision. We don't have the "Effective Date" constraint in this paragraph. So

15:22 this is a potentially evolving provision, in the sense that, within the constraints of the Treaty, what is customary and accepted practice does change.

This also relates to Mr Chairman's second step of treaty interpretation from yesterday, where he noted that treaty requirements sometimes allow for construction by reference to customary or accepted practices, and this will often depend on a plant-by-plant analysis. And we fully agree with that characterisation.

Now, when it comes to applying customary and accepted practice to intakes, there has of course been a development since 1960. They've been more in the nature of fine-tuning rather than dramatic differences. So the functions, and what you need for an effective intake, or a satisfactory intake, have remained stable; but how you achieve that obviously has changed over time.

So you want to have an intake that minimises the entrainment of sediment, that's capable of excluding floating debris, that can be cleaned of floating debris, that minimises vortexing and that is easy to maintain. That's the same as in 1960. But the way that we do that has changed.

Just to give you some examples, the practice is to

15:24 have now more automated machines for the cleaning of the intakes. We saw an example of that at Neelum-Jhelum with the crane.

There's technological developments now leading to even more sophisticated machines, such as autonomous underwater robots. That wouldn't have been envisaged in 1960 but it certainly can be used as a practice.

Also the way that trash racks are designed in intakes, they are now designed frequently to handle the maximum head loss across the rack, which wouldn't have been done necessarily in 1960.

And as I mentioned, we have improved hydraulic design and understanding of how to make these intakes most effective, including the way that the inlet leads up to them.

So we see that there is a role for customary and accepted practice, and that this has been included here in 8(f). And just to give the ordinary meaning, "customary", we would say, is: in accordance with established customs of a particular community. Here that would be hydropower engineering. And "accepted" means: generally recognised as correct and valid.

Now I'm turning to India's approach to the interpretation of 8(f).

(Slide 62) This is India's preferred power intake

15:25 design. It is fully submerged, entirely below the dead storage level. And this is the design for the Baglihar HEP and it's from figure 10.12 of the Memorial.

(Slide 63) This design is also sheen seen in the publicly available Bureau of Indian Standards for hydraulics intakes, which were reaffirmed in 2000. And you see how, as compared to the example I showed earlier of a surface intake that then descends into the tunnel, you just have a straight intake here, straight from the reservoir into the tunnel.

Now, this type of design is a completely submerged design. And it means that sediment management must be undertaken, because this design, without the skimming wall and with its deep placement, will quickly face sedimentation problems. This creates a false necessity for, in India's view, reservoir flushing.

India's approach to its intake design is linked to its position on pondage, as calculated under paragraph 8(c), because the pondage determines the size of a particular plant's operating pool and, by extension, the location of its dead storage level. And this aspect will shortly be addressed by Dr Miles.

(Slide 64) This again has been the subject of discussion in the Commission. Pakistan's Commissioner, in the 108th meeting (P-70) observed that

15:27 a surface-level intake is recommended for run-of-river HEPs:

"He elaborated that [the] higher Pondage created the requirement [for a] submerged intake for which the water seal was required for protecting it from entry of air and formation of vortex at the mouth of the tunnel ... pushing the intake further down. This ... causes the intake to draw coarser sediment particles which are harmful for the turbines and exposes it to the risk of overwhelming by the deposited sediments. Pakistan['s] Commissioner suggested that instead of providing this arrangement the designers should go for surface intake and obviate the possibility of its overwhelming by deposited sediments."

(Slide 65) But India rejected this suggestion in the same meeting, with their Commissioner saying:

"... Pondage does not dictate the type and location of the power intake. Hydraulics, topography, geology, techno-economics and many other factors play a role in the decision-making ... more often than not, site conditions do not allow surface intake as a techno-economically feasible option. Keeping in view that Pondage is needed to meet load fluctuations, intakes accordingly provided with requisite water seal."

Meaning submerged in all cases.

15:29 (Slide 66) In the discussion specifically on the Ratle plant, Pakistan's Commissioner noted that reduced pondage would reduce the operational pool depth and make it:

"... possible to provide a surface intake which can subsequently be converted to [a] pressure conduit a short distance downstream of the intake face."

India replied to that suggestion by saying:

"... satisfactory operation as well as techno-economics requires a deep seated intake as proposed by India ... at this project site the river carries significant suspended fines and hence a surface intake is not justifiable on that account."

And the same concerns were aired in later meetings.

I think, Mr Chairman, that brings us to the time for the coffee break. I estimate I have maybe 10 to 15 minutes more after that point.

THE CHAIRMAN: Very good. Why don't we take the break, we'll come back and have you finish your presentation, and then we will be moving on, I think, to Dr Miles. So let's do that, and we will resume at 4.00 pm.

PROFESSOR WEBB: Thank you.

THE CHAIRMAN: Thanks.

(3.30 pm)

(A short break)

16:01 (4.01 pm)

THE CHAIRMAN: Okay, I think we are back in session. Professor Webb, over to you.

PROFESSOR WEBB: Thank you. If my slide could be displayed, please. (Pause)

THE CHAIRMAN: This is once again Murphy's law coming into play, I think!

PROFESSOR WEBB: (Slide 66) Just before the break, I was showing you the exchange between the Pakistani Commissioner and the Indian Commissioner on this issue of the placement of intakes (P-83). And the Indian Commissioner had made the point that:

"... satisfactory operation as well as techno-economics requires a deep seated intake as proposed by India ..."

(Slide 67) However, a submerged intake of the type that India prefers is difficult to justify in circumstances where, as you can see in this drawing, the design of an intake can allow for a surface-level intake which meets Pakistan's concerns, while maintaining a water seal for vortex control above the headrace tunnel that would meet India's concerns. So India's deep intake could easily be modified by incorporating a skimming wall to raise the minimum invert level of the intake, which is the outlet used to divert water to the

16:03 plant.

(Slide 68) And this is shown in this comparison of intake designs. So you see, on the left, India's design: a straight intake as deep as possible. However, in a modified Treaty-compliant design, you can incorporate a skimming wall that would raise the effective invert elevation of the intake. It not only renders the design Treaty-compliant but, by withdrawing the water near the surface, it will deliver water containing a lower sediment content, in particular of sands, into the turbines.

So sediment management generally compels the adoption of a surface-level intake with minimal intrusion below the dead storage level. And the selection of India's design, on the left, a deep intake, knowing that this is operating in a region with a high sediment load, is not a sound practice. And it leads into this sort of perpetuation of a cycle, where you have the intake that's deep, that's therefore very susceptible to problems of sediment. We then have designs from India that insert an orifice spillway below the intake because they need to, in their view, engage in drawdown flushing to create a buffer between the intake seal and the sediment level; all of which is in violation of the Treaty.

16:05 So I now turn to how the Neutral Expert addressed this issue of intakes in the Baglihar proceedings. He considered two competing designs for the intakes that I showed you on the previous slide: the deep intake of India sitting near the bottom, and Pakistan's alternative selective withdrawal intake situated partially above the dead storage level.

(Slide 69) Unfortunately, in his analysis of these intake designs, he committed some very serious errors.

First of all, he only assessed India's design by reference to paragraph 8(f), though as a fully submerged intake below the dead storage level, he should have also applied the even more stringent conditions under 8(d).

He also gave undue weight to the need to prevent vortexing, and didn't take sufficient account of the even more serious problem of sediment ingress. So he erred in prioritising technical reasons for lowering the intakes -- vortexing -- while ignoring the technical reasons for raising them, which was to minimise sediment entrainment.

He also said that an assessment of intake height could take place without considering whether anti-vortex devices could effectively be introduced into the design. He said (PLA-2, paragraph 5.10.7) -- and the quote is on the slide:

16:07 "... recourse to anti-vortex devices at the design stage is not common practice, and should be limited to particular cases where other measures cannot be undertaken to provide protection against the development of vortices."

But paragraph 8(f) actually compels that such options be assessed with its reference to "satisfactory and economical construction and operation of the Plant as a Run-of-River Plant".

(Slide 70) The Court has asked, in Procedural Order No. 6:

"... what is to be taken into account for the purposes of designing submerged power intakes for a plant and what is to be excluded?"

(Slide 71) So we say the relevant factors include that the intakes are built and operated satisfactorily and economically in the light of the challenges that a run-of-river plant in the Himalayas faces. That means sediment ingress into turbines, vortexing and other operational questions.

The other relevant factor is the need to place the intake's invert at a level to allow pondage to be drawn upon, which will be below dead storage level but not completely submerged.

We say irrelevant factors are: factors that are

16:08 related to non-run-of-river plants, they have very distinctive needs when it comes to intakes; factors that are not directly related to the HEP's operation, that's clearly in the large of 8(f); and factors unrelated to the designated range of the plant's operation.

(Slide 72) So I come now to the key takeaways from this analysis of paragraphs 8(d), (e) and (f).

As we've been discussing, the choice of site is crucial. Not every potential site may be viable for development based on geology, seismic activity, topography, hydrology, social and environmental impacts and economics, but also because of the constraints of the Treaty. It may be that a site is not suitable for an Annexure D.3 HEP. And the solution is for a different site to be chosen, not to build and operate a non-compliant HEP.

There's always going to be more than one option for a site, and there is no such thing as the perfect site. There will be a range of factors to take into account, of which the Treaty is a requirement for India on the Western Rivers.

The design and operation of a hydroelectric power plant never takes place in a vacuum: it always operates within a set of constraints. And the Treaty, with its peace, treaty and hydro bargains, is a set of

16:10 constraints that apply to India's plants on the Western Rivers. And as with all engineering challenges, it's necessary to find a solution within the overall context of prevailing constraints.

On low-level outlets, the default is not to have a low-level outlet in an Annexure D.3 HEP. India must establish its burden that there is a necessity for a low-level outlet. If it does manage to establish that, then they need to be as small as possible, as high as possible in the reservoir. The strategy of using low-level outlets to pass the design flood has resulted, in breach of the Treaty, in the maximum size of the low-level outlet, not the minimum size.

For spillways, the default position is to have a surface ungated spillway. India may show -- and it may discharge the burden -- that a gated spillway is necessary due to conditions at site of the plant. If it manages to do that, then the bottom level of the gates has to be located as high as possible, the design must be sound and economical, and that will usually mean a crest-gated spillway rather than a fully submerged orifice spillway.

For power intakes, the most effective as well as the Treaty-compliant design will be a surface intake that sits largely above the dead storage level and is

16:12 designed to minimise the entrainment of coarse sediment.

Mr Chairman, that concludes my submissions. I'm happy to answer any questions.

THE CHAIRMAN: Thank you, Professor Webb. (Pause)

I don't think we have any questions for you. Thank you so much for your presentation.

PROFESSOR WEBB: Thank you. And I ask that you now call Dr Miles to address you on freeboard. Thank you very much.

THE CHAIRMAN: Very good. It is indeed Dr Miles's time, after sitting patiently, as Sir Daniel said.

So, Dr Miles, you are welcome to come to the podium.

DR MILES: Thank you. If you will just give me a few moments to set myself up. (Pause)

Ready when you are, Mr Chairman.

THE CHAIRMAN: Please proceed.

DR MILES: Thank you.

(4.15 pm)

Submissions on Freeboard

DR MILES: (Slide 1) Mr Chairman, members of the Court, it is a pleasure to be before you again, this time in an environment in which more than cordial greetings are possible. Today I will be addressing you on the question of the HEP's freeboard, which is regulated by paragraph 8(a) of Annexure D of the Treaty.

16:15 (Slide 3) Now, as we're all aware, the Court has asked a question on freeboard in its Procedural Order No. 6, and we've got that now on the slide for you:

"With respect to Annexure D, paragraph 8(a), what is to be taken into account for the purposes of designing a freeboard for a plant and what is to be excluded?"

(Slide 4) So now we have on the slide paragraph 8(a) itself. First, of course, we have the common paragraph 8 chapeau:

"Except as provided in paragraph 18, the design of any new Run-of-River Plant ... shall conform to the following criteria: ..."

And then we have the text of paragraph 8(a) itself:

"The works themselves shall not be capable of raising artificially the water level in the Operating Pool above the Full Pondage Level specified in the design."

Now, on the slide as well we have a further provision which, in Pakistan's submission, provides essential context for paragraph 8(a). And that is, of course, paragraph 8(b), which states that:

"The design of the works shall take due account of the requirements of Surcharge Storage and of Secondary Power."

So between these two provisions, paragraph 8 defines

16:16 the permissible height of a HEP freeboard.

Now, in this presentation we will explore how these provisions are to be unpacked, so that the Court's question on freeboard may be answered.

(Slide 5) To that end, I propose to proceed as follows. First, I will revisit the concept of HEP freeboard, picking up on some of the concepts that Dr Morris has mentioned. Second, I will turn to paragraph 8(a) and explain how it is to be interpreted by reference to the relevant definitions in paragraph 2 of Annexure D. Third, I will address India's case on freeboard and explain why it is incorrect. And fourth, I will return to the Court's question and proffer Pakistan's suggestion on how it might be answered.

(Slide 6) So let's start with the engineering concept of the freeboard. Dr Morris has already kindly discussed this, and so I can hopefully be brief.

(Slide 7) On the slide you will see our old friend the Neelum-Jhelum hydroelectric plant, and we've got the freeboard and the full pondage level marked in yellow.

So as you can see from the diagram, the freeboard is that part of the dam wall between the normal top of the reservoir, so the full pondage level, which for the NJHEP is 1,015 metres above sea level, and the lowest portion of the dam wall that is not designed for

16:18 overflow.

So why does a dam need this? Safety. Freeboard provides an additional margin between the reservoir and the top of the dam. This prevents the reservoir from overflowing in the face of sudden and unexpected events, such as: waves caused by wind; waves caused by earthquakes or landslides; sudden floods depositing large amounts of water into the reservoir; or the failure of a gated spillway, either because of human or mechanical error.

Such overflow is referred to as dam "overtopping". And depending on the type of dam used, the consequences can be catastrophic. For an embankment dam, overtopping will lead to the erosion of the dam, and the result of that is dam collapse. Teesta III, the Indian HEP to which Dr Morris and Professor Webb drew your attention, was one such example of an embankment dam, a rock-filled concrete-faced dam.

But when dealing with a pure concrete dam, however, the consequences of overtopping are usually less severe, due to the resistance of concrete to rapid erosion. Indeed, some concretes dams may be designed to be overtopped for short periods of time.

Now, the result of all this, of course, is that you will normally need a higher freeboard with an embankment

16:19 dam than you will with a concrete dam.

(Slide 8) Now, what I've just said about the sort of general purpose of freeboard and the way in which it is incorporated into a HEP is on the slide. That's from the US Bureau of Reclamation's Criteria and Guidelines for Computing Freeboard Allowances (P-535). There's no need for me to read it out. I've just got it flagged there so that you can examine it for yourselves in slower time.

Now, another issue at play when determining freeboard is spillway design, with which you are now all extremely familiar. This may result in the introduction of yet another concept into freeboard design, which is that of surcharge storage.

Surcharge storage, also known as flood surcharge, is a portion of additional storage above the normal full pondage level. It's empty space, intended only to be filled in the event of a flood.

(Slide 9) Now, of course this prompts the question: Dr Miles, if you have a spillway, why do you need flood surcharge? And of course the image on the slide provides the answer. Simply put, the need for this additional space is driven by spillway design.

An ungated spillway, on the left, has a fixed and uncontrolled discharge capacity. To put it in blunt

16:20 terms, it can't get any deeper than it already is. It may not, therefore, be able to discharge the entire design flood of the HEP immediately. Surcharge storage above the spillway allows the discharge to increase as the water level rises.

Now, a gated spillway -- and that's examples (b) and (c) on the slide -- whether surface or orifice, may have its gates sized such that the HEP's design flood may be discharged without the need for surcharge storage. Smaller gates may, however, require the inclusion of a small amount of surcharge storage for much the same reason as an ungated spillway: the higher water level with surcharge increases the spillway capacity without risk of overtopping.

(Slide 10) Now, where surcharge storage is included in HEP design, we end up with two types of freeboard, which you can see on the slide. So first of all we have the normal freeboard, which is from the full pondage level to the top of the dam; and then we have the minimum freeboard, which sits within the normal freeboard. And that designates the margin between the high flood level, at the top of surcharge storage, and the top of the dam.

So when we pull all this together, we can see that we've got a number of factors that are going to start

16:22 influencing our freeboard height. I'll address these all later by reference to the relevant international standards. But for present purposes, we can split these into two categories: the first concerning HEP design, and the second, site conditions.

(Slide 11) So far as HEP design is concerned, we have -- and you can see here on the left of the slide we've got design factors and site conditions -- we've got the type of dam used. As I've already said, an embankment dam is going to need more freeboard than a concrete dam.

And then we also have spillway design. As we've noted already, an ungated spillway will need more freeboard than a gated spillway, due to the need to incorporate surcharge storage.

So far as site conditions are concerned, we have meteorological conditions, particularly with respect to wind at the HEP site. And it's this wind that leads to waves, which can overtop the dam, creating a possible collapse risk for an embankment dam.

Then we've got the bathymetric conditions, which refer to the depth and length of the reservoir, both of which can affect the formation and movement of these waves within the reservoir.

And then finally, we have a variety of geological

16:23 conditions which may cause movement of the dam or displacement of water in the reservoir, including dam and foundation consolidation, site seismicity, and risk of landslide.

So if we can put this in roundabout general terms, an embankment dam with an ungated spillway in a windy and earthquake-prone zone will need a higher freeboard than a concrete dam with a large gated spillway in a sheltered region with stable geology.

But this is all, of course, a question of engineering. What is required in terms of freeboard will vary from site to site and from dam to dam. As always in these things, there's no one-size-fits-all approach.

(Slide 13) Now that we know what freeboard is, we can see how it's regulated by paragraph 8(a). And that's now back for you on the slide.

So, first observation -- hands up -- freeboard is not mentioned in there at all. But it is subsumed in the fact that paragraph 8(a) refers generally to "the works", a term that, within the Treaty, includes the entirety of the HEP structure, including the freeboard.

So what this means is that freeboard regulation under paragraph 8(a) forms part of the wider examination of the way in which the HEP is designed. And it's this

wider interaction of freeboard with the works as a whole that will determine whether a HEP is paragraph 8(a)-compliant.

What is paragraph 8(a) intended to prevent? Well, we know this from the words that follow:

"The works ... shall not be capable of raising artificially the water level in the Operating Pool above the Full Pondage Level specified in the design."

(Slide 14) Now, unpacking this statement is going to require a brief detour into the definitions section of Annexure D, which is of course paragraph 2, now on the slide. We'll be returning to deal with these in more detail tomorrow, when I will be dealing with the much anticipated question of pondage. But for now, the critical points are as follows.

The first is another general observation: the definitions that are here relevant are those dealing with the composition of a HEP's reservoir. By this, I mean that they define the water levels within the reservoir.

So if we can start at "Operating Pool" down at the bottom, paragraph 2(f) provides that this means "the storage capacity between the Dead Storage Level and the Full Pondage Level".

This leads us, in turn, to the definition of the

16:25 "Dead Storage Level", which is located at paragraph 2(a). This means "the level [of the reservoir] corresponding to Dead Storage", which is, of course, the portion of the storage not used for operational purposes. As the Kishenganga Court said (PLA-3, paragraph 505):

"... Dead Storage is ... truly 'dead' ... to be filled once, and not thereafter subject to manipulation."

As for the "Full Pondage Level", paragraph 2(d) provides that this means "the level [of the reservoir] corresponding to the maximum Pondage provided in the design in accordance with Paragraph 8(c)".

I will be leaving paragraph 8(c) right where it is for the moment; we will be talking about it in detail tomorrow. But suffice to say for present purposes, pondage is a form of live storage that can be used for operational purposes; and to that extent, it is the contents of the operating pool that defines the volume of the operating pool.

Then finally, we might look at "Surcharge Storage", as defined in paragraph 2(e). This is the "uncontrollable" -- underline "uncontrollable" -- "[live] storage occupying space above the Full Pondage Level". And we've addressed this briefly already when

16:27 dealing with paragraph 8(b) and the concept of flood surcharge.

(Slide 15) So if we pull all this together, we get the longitudinal profile of the HEP's reservoir that we have on the slide. Each long-suffering spouse or partner of a member of Pakistan's counsel team has had this drawn for them on a cocktail napkin at some point over the past two years, but you remember it possibly as figure 12.2 from Pakistan's Memorial.

Just in terms of principal features from the bottom of the reservoir up, at the bottom we see our dead storage, terminating at the dead storage level. Then we have the operating pool, filled with pondage, terminating at the full pondage level. Above the full pondage level, we have our uncontrollable surcharge storage.

That terminates in what we have termed the "surcharge storage level" on this diagram. That's obviously not mentioned in the Treaty, but it is known in almost every run-of-the-river HEP, including the NJHEP, as the "high flood level".

And we've indicated that both pondage and surcharge storage constitute live storage for the purposes of a HEP governed by Annexure D.

Then at the far left of the profile, we have the

16:28 freeboard, which is the normal freeboard, encompassing the space between the full pondage level and the top of the dam wall, and the minimum freeboard, encompassing the space between the high flood or surcharge storage level and the top of the dam wall.

When we pull all of this together, we can see what paragraph 8(a) is really driving at: India is prohibited from building a HEP that can be artificially filled beyond the full pondage level. Put another way, India cannot build a HEP in which the operator is able to simply shut the outlets and allow the water in the operating pool to rise until the usual limits of the operating pool are exceeded, allowing India more live storage than it is entitled to.

More to the point, while the additional vertical space that this additional live storage could occupy is relatively limited, once it is multiplied out across the entire surface of the reservoir -- and indeed, in this case, above the normal surface of the reservoir -- it becomes very large indeed.

(Slide 16) You will recall the elevation capacity curve introduced by Dr Morris in this respect, which is now back on the slide. And the point is a simple one: to coin a phrase, even an inch of additional depth will result in considerable additional storage when it's

16:29 a mile wide. So several metres of additional freeboard height at this elevation will lead to considerable additional live storage.

THE CHAIRMAN: Dr Miles, if you don't mind going back to the prior slide, 15.

DR MILES: Yes.

THE CHAIRMAN: I'd still like to hear you say a little bit more about how we should be interpreting paragraph 8(a).

As you, I think, previously noted, it says:

"The works ... shall not be capable of raising artificially the water level ... above the Full Pondage Level ..."

Then we have in (b): well, we can "take due account" of surcharge storage. That seems, by its text, to say it's fine to go up to the green line, but you can't go above that.

DR MILES: I'm coming on to exactly that point.

THE CHAIRMAN: Alright.

DR MILES: So if you bear with me, I'll be right with you. If I have not answered the question after that, you have licence to pull me up and I'll do my very best.

(Slide 17) Now, as to why the Treaty is hostile to this idea of overfilling that we've been discussing, we need only consult the critical rule from which Annexure D departs, which is Article III.

16:31 Article III has already been covered in some detail by Professor Webb, and I will be returning to it tomorrow. But for present purposes, the language of Article III(4) is key:

"Except as provided for in Annexures D and E, India shall not store any water of, or construct storage works on, the Western Rivers."

As Professor Webb has explained, the Treaty is presumptively suspicious of any attempt by India to store the waters of the Western Rivers. Once we understand this, we can see why paragraph 8(a) of Annexure D is framed as it is. Between Article III(4) and Annexures D and E, the Treaty tightly controls India's right to store the waters of the Western Rivers.

And now I hope I'm coming on to what the Chairman's point in his question was.

(Slide 18) This hostility is reflected in the first three subparagraphs of paragraph 8. Looking at these on the slide from the bottom up.

Paragraph 8(c) gives India a fixed amount of pondage, being the principal form of live storage under the Treaty.

Paragraph 8(b) requires India to incorporate such surcharge storage as may be necessary into its design, and that storage is by definition uncontrollable; and

16:32 "uncontrollable" is the answer to the Chairman's question.

And paragraph 8(a), with which we are presently concerned, is inserted to guarantee that India cannot obtain more pondage than it is entitled to by the simple expedient of ensuring that the operating pool of an Annexure D.3 HEP cannot be deliberately overfilled.

Now, another point that might be noted is that these three paragraphs together constitute what might be called the "storage criteria" of paragraph 8 of Annexure D. And these tell India the limits within which its reservoir is to be designed.

The other provisions of paragraph 8 -- paragraphs 8(d), (e) and (f) which Professor Webb dealt with compendiously just before me -- deal with those HEP features that allow India to manipulate the content of the reservoir, so outlets, spillways and intakes. And we can refer to these as the "control criteria" of paragraph 8.

There is a critical difference between the storage and control criteria. Whereas the control criteria give a margin of objective appreciation, with references to "sound and economical design" and so forth, the storage criteria posit strict and absolute limits: maximum pondage "shall not exceed" twice the pondage required

16:33 for firm power; the design of the works "shall take due account" of the need for, or indeed the lack of need for, surcharge storage; and the works "shall not" be capable of artificially increasing the level of the operating pool above the full pondage level.

So how is India to ensure that the reservoirs of its HEPs cannot be filled above the full pondage level? There are two answers to this.

The first -- which is the answer to the Chairman's question -- concerns whether water within the surcharge storage can drain away freely at the full pondage level following a flood. This engages, in turn, questions of spillway design and surcharge storage.

The second answer concerns freeboard configuration, which can only be properly understood in light of the first answer.

So I will address each now in turn, starting with the full pondage level.

(Slide 19) On the slide we've got a photo of an ungated surface spillway -- I think this one's from Queensland -- combined with its diagram of its freeboard arrangements.

If we assume that the crest of the spillway is at the full pondage level, is this design compliant with paragraph 8(a)? Answer: plainly, yes. If an attempt

16:35 were made by the HEP operator to fill above the full pondage level, the ungated spillway would prevent additional water from being stored. The reservoir would simply overflow the crest and discharge into the river below the dam.

A further important point is that this arrangement is not offended by surcharge storage, which occupies the space above the full pondage level. As to why this is the case, paragraph 8(a) prohibits only the artificial -- that is, controlled -- filling of the operating pool above the full pondage level. The HEP operator cannot be permitted to simply shut all the outlets and watch the reservoir fill. And second, paragraph 8(b) qualifies paragraph 8(a) by requiring surcharge storage to be taken into account, but paragraph 2(e) confirms that surcharge storage is uncontrollable in character.

So to sort of put a finger on the Chairman's question: yes, you are allowed to fill your HEP to the high flood level, provided the space between the full pondage level and the high flood level is filled only by uncontrollable surcharge storage.

Now, when a HEP includes an ungated surface spillway, both of the criteria that I just mentioned are met. The ungated character of the spillway prevents the

16:36 HEP's reservoir from being filled above the full pondage level, for the reasons that I've already explained. And at the same time, that same spillway also guarantees that our surcharge storage remains uncontrolled. While it may be filled in the case of a flood, the HEP operator cannot manipulate the surcharge deliberately, as the floodwater will drain away immediately over the ungated spillway. And the result of this is a HEP that's paragraph 8(a)-compliant.

So that's the position with respect to an ungated surface spillway; what about a gated surface spillway?

(Slide 20) Assuming the top of the gates for our ungated surface spillway are set at the full pondage level, which is the normal practice, this design would also be paragraph 8(a)-compliant. Because, as we can see from the photograph -- which again you'll recognise from Neelum-Jhelum -- gated surface spillways usually include a gap between the top of the gate and the dam wall through which uncontrolled flow can occur.

This design feature allows for free overflow of the reservoir in flood conditions, allowing for safe spill-over in the event of gate malfunction or delay. For the purposes of paragraph 8(a), that gap performs much the same function as an ungated surface spillway -- admittedly with a far smaller discharge capacity --

16:38 preventing artificial filling of the operating pool above the full pondage level.

This also means that any surcharge storage, to the extent it's even required in such a design under paragraph 8(b), remains uncontrolled. Again, if the surcharge storage were filled and the gates closed, floodwater would still escape the reservoir through this free overflow feature.

But where problems really start to emerge -- as Dr Morris said earlier -- under paragraph 8(a) is with respect to India's preferred design: the orifice spillway.

(Slide 21) Why this is the case is immediately apparent from the slide. An orifice spillway -- and you'll recognise the gates once more from Neelum-Jhelum -- is designed to be wholly submerged. As such, its gates do not have a free overflow feature, like a gated or an ungated surface spillway, but form a watertight seal with the dam wall.

This means that there will ordinarily be no outlet between the top of the orifice spillway gates and the top of the dam, allowing the reservoir to be filled artificially above the full pondage level, contrary to paragraph 8(a). And it will also mean that any surcharge storage in the design will be controllable, 16:39 contrary to paragraph 8(b).

The upshot of this is that paragraphs 8(a) and 8(b) impose a constructive ban on a HEP design that includes only an orifice spillway.

Now, this does not necessarily create a problem for India. As Professor Webb explained, paragraph 8(e) does, in certain circumstances, allow India to include an orifice spillway in its design, if required by the conditions at the site together with considerations of sound and economical design and so forth.

But what it does not allow is for India to include only an orifice spillway in its designs. It must also include in the design another type of free overflow feature, preferably an ungated surface spillway, that renders uncontrollable both the surcharge storage and the freeboard.

(Slide 22) We showed why this is the case in figure 12.3 of the Memorial, which is on the slide.

On the right, we see a paragraph 8(a) non-compliant HEP design. As you can see, this has an orifice spillway only, and can easily be filled by India above the full pondage level simply by closing the spillway gates and allowing the water level to rise.

These problems are not, however, present for the design on the left of the image. Here, an ungated

16:40 surface spillway is included in the design at the full pondage level. If India were to fill past that level, the excess water would be discharged through this free overflow feature, and what was, in the design on the right, controllable surcharge storage becomes, in the design on the left, uncontrollable surcharge storage.

(Slide 23) Now, as I think Professor Webb mentioned, combination spillways of this kind are by no means unheard of. You'll recall similar points being made by Dr Abbas on the site visit by reference to the spillway at the Karun-III HEP in Iran, designed by our very own Peter Rae, and that's currently on the slide.

Karun-III includes three different spillways: an orifice spillway, a surface gated spillway and an ungated surface spillway. Provided that at least one of the surface spillways is at the full pondage level, this design would be paragraph 8(a)-compliant, at least insofar as our overfilling is concerned.

And that's also a feature of the NJHEP on the right; we saw that on the site visit. As you will recall, the NJHEP includes an orifice spillway, but also includes a surface gated spillway as an auxiliary structure to assist in passage of the design flood and allow for the passage of floating debris. Provided the gap at the top of the auxiliary spillways gates is at the full pondage

16:42 level, this design would also be paragraph 8(a)-compliant; again, at least so far as the possibility of overfilling is concerned.

So those are the points that I wish to make on the way that paragraph 8(a) regulates what happens at the full pondage level. So that's our first part of the analysis.

(Slide 24) On to the second, freeboard; or more particularly, the height of the freeboard.

As I mentioned previously, although freeboard is not mentioned expressly in paragraph 8(a), it is nevertheless part of the works, and nevertheless falls to be regulated by paragraph 8(a). And the reason why is on the slide.

Now, you may recognise these from the NJHEP: we walked past them a couple of times. They're stoplogs, which are watertight barriers used to seal off spillway gates so that they may be de-watered for maintenance purposes.

The import of these with respect to our surface gated spillway, our free overflow feature, is obvious. Ordinarily, the gap at the top of the gates will serve as a free overflow structure that will prevent the reservoir from exceeding the full pondage level. But with stoplogs in place, that gap will be blocked, or at

16:43 the very least diminished in size, allowing the operating pool to be overfilled.

The same can be said, by the way, for ungated surface spillways. Although these are not usually constructed with stoplogs in mind -- which is unsurprising, because they don't have moving parts, and therefore don't require maintenance in the usual course of events -- the crest elevation can still be raised -- that is to say, the spillway can be blocked -- using structural elements such as fusegates or flashboards, which are designed to break away during large floods, but can still be used to overfill the operating pool.

It's for this reason that paragraph 8(a) limits the height of a HEP's freeboard to that of the minimum required for safety in the circumstances.

(Slide 25) This is confirmed by the argument before the Neutral Expert in the Baglihar case. We've got his summary on the slide for you (PLA-2, paragraph 5.8.1). And at the top we see:

"For a surface gated spillway, the artificial raising of the level is possible by increasing the height of the gates; however, this is not technically easy unless measures for this purpose were allowed for in the initial design."

Pausing there, stoplogs may plainly be allowed for

16:44 in the initial design: the NJHEP is proof of that.

Professor Lafitte also, in that paragraph, mentions another method by which artificial raising of the operating pool can be accomplished, which is that you simply install bigger gates after the fact.

He then continues:

"In the case of ungated surface spillways, the artificial raising of the full pondage level is easier. It is a generally accepted way of improving the performance of an existing dam. This is achieved by placing gates on the crest (possibly fusegates) so as not to affect the spilling capacity of the spillway."

So far, this is entirely consistent with what I've set out.

Then finally, the final paragraph:

"A way to limit the technical possibility of raising the Full Pondage Level is to limit the freeboard to the minimum required."

(Slide 26) This consideration is then carried through to his intermediate conclusion which we have for you on this slide. And he says there (PLA-2, paragraph 5.8.9):

"The possibility of [raising further] the Full Pondage Level and the extent of ... possible raising is directly related to the height of the ... freeboard."

16:45 (Slide 27) And then on to his final analysis (paragraph 6.4.2):

"... the dam crest elevation should be set at the lowest elevation compatible with a sound and safe design based on the state of the art."

Now, on this issue, Professor Lafitte got it right, although the reason for this outcome was that the issue of the freeboard is not one that was caught in what we say was the mangle of the Neutral Expert's methodological errors on the interpretation of the Treaty. Paragraph 8(a) of Annexure D regulates the height of a HEP's freeboard to limit further the artificial raising of the operating pool above the full pondage level.

Now, this is not to say that India does not get a freeboard for its Annexure D.3 HEPs. To the contrary, given the role that the freeboard plays in dam safety, these HEPs must have a freeboard for the safety of India and Pakistan both. But -- and herein lies the rub -- that freeboard must be no higher than safety requires.

Now, I should add: this is a position that's consistent with reality. HEPs are, as we know, expensive to construct. Every additional metre of height to a HEP's dam may add millions of dollars in cost; a cost that will not necessarily benefit the HEP

16:46 operator, as a higher freeboard does not translate to a higher generating head that could be used for increased power production. As such, paragraph 8(a), insofar as its regulation of freeboard is concerned, merely confirms what is already implicit in the economics of HEP construction.

Now, this all, of course, prompts the question of what freeboard safety requires. In Pakistan's submission, this is an engineering question to be governed by the relevant international standards.

(Slide 28) On the slide we have a summary from the US Bureau of Reclamations 1982 technical memorandum on Freeboard Criteria and Guidelines for Computing Freeboard Allowances (P-535), to which I referred earlier. This is the most complete standard that Pakistan has been able to locate. Of course, there may be others; but to my understanding, everything is kind of broadly similar. Several of them are on the record, and we're happy to provide references if you think it convenient.

For present purposes, I could perhaps point you to two: ICOLD's Bulletin No. 82 on Selection of Design Flood, that's P-0536, and in particular, section 4.6 thereof is most illuminating; and the US Federal Energy Regulatory Commission's guidelines concerning Selecting

16:48 and Accommodating Inflow Design Floods for Dams, P-0532, and in particular, section 2-4.3.

Despite its age, the Bureau's memorandum, which we have again on the slide, has been referred to regularly with approval, and it's still referred to regularly with approval, including in the Federal Energy Regulatory Commission guidelines I just mentioned, which are from slightly more recently: 2015.

Returning to the slide, we can see the Bureau's presumed or default position -- and it is only a presumption, it's only a default position -- on concrete dams, which is that:

"A standard 3.5-foot (1.1-m) high parapet wall provides all of the freeboard that is required for concrete dams. This wall is intended to keep waves from washing over [dams] during high reservoir levels."

THE CHAIRMAN: Just a moment Dr Miles.

DR MILES: Yes.

THE CHAIRMAN: Dr Buytaert.

PROFESSOR BUYTAERT: Sorry to interrupt you. But in the previous slide, would you be able to clarify whether the freeboard that's referred to here would be the minimum freeboard, or freeboard including surcharge?

DR MILES: This, I believe, is the minimum freeboard. If you need surcharge, that's obviously going to be

16:49 dependent on the size of your spillway gates or your spillway. So I believe this would probably be minimum freeboard.

I will of course check that with my engineering colleagues and if I've got that wrong, I'll get right back to you.

PROFESSOR BUYTAERT: Please do. Thank you very much.

DR MILES: Now, in terms of factors of freeboard height, including this conclusion, the Bureau requires consideration of the following.

Floods, meaning the design flood and the probable maximum flood.

Wind setup and wave run-up. These are the predominant factors in the determination of the freeboard and consider the circumstances in which large waves could develop at the HEP site. These include: wind velocity, duration and orientation with respect to the reservoir, as well as the "fetch", being the length of the open-water approach across which the wind can cause waves to develop; and of course we also include there the height and steepness of any waves and the slope of the dam face.

Next, we also have reservoir operations. This refers to how the HEP operator plans to operate the reservoir at different times of the year. For example,

16:50 if the HEP operator wants to keep the operating pool empty during the monsoon season for sediment management purposes -- and as Dr Morris has indicated, that is in fact best practice -- the threat of overtopping the dam during a flood will be much reduced because you've got your whole operating pool which effectively becomes, in that circumstance, a form of surcharge storage.

We then have the possibility of gate failure. The greater the possibility of gate failure, the higher the freeboard required, and this is going to depend on the type of spillway used. So for an ungated surface spillway, there's obviously no threat of gate failure as there are no gates, but there remains the possibility that the spillway could be blocked by debris during a flood. So that's really going to depend on how big your spillway outlet is.

For a gated spillway, the possibility of gate failure can be exacerbated by site-specific conditions, such as: the reliability of gate operations from actual experience; the identity and experience of the dam tender; the size and complexity of gate structure, and so forth.

We then have the seismicity of the site. That refers to the possibility of earthquakes or landslides around the reservoir, both of which may cause the

16:51 formation of waves. In the case of the latter, consideration may also be given to the question of whether landslide-prone areas around the reservoir can be removed as part of the process of HEP construction.

We've got, of course, the dam type at the top, meaning the use of a concrete or embankment dam; and including the risk, in the latter case, of whether the foundations of the embankment are likely to settle during an earthquake.

Then we've got various additional factors, including climate change, downstream conditions and damage potential, remoteness of the dam site and so forth.

(Slide 30) Now, these track, more or less, the factors that Professor Lafitte relied on in Baglihar, although in that case he was confined to considering a concrete dam and was not in a position to opine on the proper approach to be taken to an embankment dam.

In calculating the freeboard at the Baglihar HEP, Professor Lafitte considered a variety of site-specific scenarios, which is the usual in this situation. The principle in play here is that the combination of various factors should have a similar probability of occurrence for any scenario considered.

So normal freeboard is determined for a flood with a high probability of occurrence in the life of a dam

16:53 combined with a high wave condition. Extreme freeboard conditions would be evaluated by developing several scenarios with different combinations of flood, wind, gate reliability, each with a similar combined probability. And it would be unusual to combine the most extreme flood with extreme wave conditions and extreme malfunction conditions. I mean, that's just not the sort of thing that you would expect to happen in the lifetime of the dam, at least in a probabilistic scenario.

So to that end, Professor Lafitte considered the four scenarios that we have on the slide.

First, he considered what would occur during the statistical 1-in-10000-year design flood, assuming the initial level of reservoir was at the full pondage level and all spillway gates were operating, taking account of wind setup and wave run-up.

He then considered what would occur during the probabilistic PMF, again assuming that the reservoir was at the full pondage level and the spillway gates were all fully operational, taking account again of wind setup and wave run-up.

He considered what would occur in the so-called "n-1" scenario in which one of the spillway gates malfunctions during a flood event.

16:54 And then finally, he considered what would occur in extreme wind conditions, noting that this scenario would not be associated with any low-frequency flood event.

And applying these scenarios and their likely consequences to the Baglihar HEP, he saw fit to reduce its freeboard from 4.5 metres above the full pondage level to 3 metres above the full pondage level.

Now, what this consideration demonstrates is that, as with many things in this field, a variety of things need to be taken into account when we're considering freeboard height. These are broadly agreed as between the international standards, although some standards provide for detail than others.

(Slide 31) Now, it's for this Court, expert lawyers and expert engineers, to determine which criteria suit it best. But the following broad categories may serve as a useful starting point.

So first we have our type of dam. Do we have a concrete dam? Do we have an embankment dam? What's the risk of erosion if it's overtopped?

Then we have our flood conditions. What's the design flood? What's the PMF? What's the capacity of the reservoir to absorb the flood, if it arrives?

We have wind and wave conditions. Do we have severe winds at the site? What's the reservoir orientation?

16:55 What's the wave run-up?

Then we have our type of spillway. Are we dealing with a gated or an ungated spillway? Are we dealing with the risk of gate failure? What are the consequences of gate failure? Do we need flood surcharge?

Then we have seismicity and geology. What's our earthquake risks? What's the consequences of an earthquake? Ditto for landslides. And is removal of landslide-prone areas a possibility during the process of HEP construction?

Finally, we've got our reservoir operations. How is the reservoir going to be operated in flood conditions? And more particularly, is the operating pool going to be empty in the monsoon?

(Slide 32) This ends, for now, my submissions on Pakistan's position on the proper interpretation of paragraph 8(a) of Annexure D, and I will return to that in closing. Before I do, however, it's necessary to address India's case on this question, and I hope to do so relatively quickly.

Detailed statements of India's case were made by its Commissioner during the 109th and 110th PIC meetings in September 2013 and August 2014 with respect to the RHEP; that's the Ratle plant.

16:56 Now, pausing there, I emphasise that Pakistan is not, in this phase of the proceedings, asking you to reach a conclusion on the proper freeboard for the RHEP. I mention it here merely as an illustration of what India's position on freeboard is as a general matter.

(Slide 33) So on the slide we have India's position at the 109th meeting (P-83), and it starts with the Indian Commissioner declaring the difference between the parties:

"The calculated value of Free Board by Pakistan is 1.1m ..."

Guess where that number came from:

"... as against that of India's value of 2.07m."

Pausing again. Although that difference may appear minor, it should be borne in mind, as I said earlier, that the contested metre will be located at the very top of -- and indeed above the surface of -- the reservoir, taking in the largest possible surface area. You'll recall once more Dr Morris's elevation curve. If India is able to fill that space, it will obtain a considerable volume of additional storage in a manner not permitted by the Treaty.

THE CHAIRMAN: Dr Miles, a question from Mr Minear.

DR MILES: Yes.

MR MINEAR: Dr Miles, I understand where you got 1.1 metres

16:58 of freeboard. Where did India come up with 2.07 metres?

DR MILES: Well, as you can see here, the difference in values of the freeboard computed by India and Pakistan seems to arise mainly because Pakistan presumed wind speed of 140 kilometres an hour. But the important part -- and I'm glad you've raised this -- is Indian Code of Practice, and I'll come back to that in a second. It's a very important point.

MR MINEAR: Thank you.

DR MILES: India's Commissioner then goes on to state -- Mr Minear preempting me -- what he considers to be the principal difference between the parties, and we've just gone over that.

And so, put another way, India is relying on wind setup and wave run-up as a basis for larger freeboard. For the avoidance of doubt, Pakistan of course agrees that is a valid concern. But the use of Indian standards on this point, the formulation of which is in India's sole control, could perhaps raise eyebrows.

"Indian side also cited ... the provisions of the ACER manual which requires that in case of deep water wave length, freeboard has to be computed as per provisions of Para 2(f) of the manual, applicable to relatively deep reservoirs. In the instant case, depth of water is deeper than one half of the wave length."

16:59 The ACER manual was actually the Bureau of Reclamation memorandum that we looked at earlier. And Pakistan obviously has no objection to that, particularly its statement that concrete dams like the RHEP require no more than a 1.1-metre parapet wall by way of freeboard in the default position.

But the Indian Commissioner then continues:

"In the instant case, [Full Pondage Level] and MWL ..."

That's "maximum water level", or high flood level:

"... are identical."

So no surcharge storage.

This actually perhaps answers Professor Buytaert's question. 1.1 metres does not include surcharge storage, otherwise Pakistan wouldn't be advocating for 1.1 metres in circumstances where there is no surcharge storage. If there was surcharge storage planned for the design, there would be more that was perhaps required.

The Indian Commissioner then continues:

"As such, when the gates are in position at [the Full Pondage Level] the spillway bridge beams have to be adequately clear of the wave splashes generated due to wind. As such, from a practical consideration, the provided freeboard of 2.0 m is bare minimum."

So here the Indian Commissioner is stating that the

17:00 full pondage level and the maximum water level are the same, so there's no surcharge storage in the design. Pakistan agrees, however, that the need for surcharge storage is a relevant consideration when calculating freeboard height.

The Indian Commissioner then mentions a further consideration, which is that the spillway bridge beams -- so the supports for the bridge that crosses the spillway at the top of the dam -- need to be insulated from splashes, and that this justifies adding a further metre to the top of the dam.

(Slide 34) Let's turn now to the 110th meeting (P-24), which sees a slight evolution in India's position. Again, this is on the slide:

"Regarding freeboard provision, ICIW mentioned that with crest gate top at Full Pond Level ... there is no possibility to raise [the] water level artificially."

This is a reflection of the fact that the RHEP design includes multiple spillways: a main orifice spillway with five bays, and an auxiliary crest-gated spillway with a single bay and a gap at the top of the gate at the full pondage level.

So because of that gap, the Indian Commissioner seems to be saying, the RHEP design is ex facie paragraph 8(a)-compliant, and the height of the RHEP

17:01 freeboard is not subject to further regulation. That's rather odd, in our submission, when Professor Lafitte reached the opposite conclusion, and India has been happy to follow Professor Lafitte on pretty much everything else.

But then we've got a further statement:

"Further, Indian side mentioned that keeping the bearings of the bridge below the [Full Pondage Level] is neither advisable nor an adopted practice throughout the world. There is no scope for reduction of depth of girder either which has been kept as bare minimum from structural point of view to keep the deflections within permissible limit. The freeboard provided by India is bare minimum from practical point of view as the girder depth under spillway-bridge ... cannot be reduced below 1.70 m from structural considerations."

And then we've got two further statements:

"There cannot be any credible argument for keeping the bearings submerged in water by keeping them below [Full Pondage Level]. It is a worldwide practice to provide freeboard of about 2 m wherever crest gated spillways are provided."

I'll come on to the first statement in a moment, but the second is very curious in its own right. No evidence for it is provided, and it takes no account of

17:02 what we already know to be the standard recommendation for a concrete dam by the Bureau of Reclamation, which is that such a dam requires a 1.1-metre parapet wall and nothing else.

And then a final statement:

"PCIW requested ICIW ... details/drawings of the girder for examination. Indian side mentioned that details have already been explained to Pakistan side."

So Pakistan's Commissioner asks for some drawings of the bridge so he can better appreciate India's position, and the Indian Commissioner says that all Pakistan's Commissioner is getting is a verbal explanation.

(Slide 35) So if we can boil down India's case on freeboard to three core propositions, based on these meeting minutes.

The first proposition is that paragraph 8(a) does not regulate freeboard, and the design of an Annexure D.3 HEP will be paragraph 8(a)-compliant merely if it includes a free overflow feature at the full pondage level.

Second, if paragraph 8(a) does regulate freeboard, then wind setup and wave run-up are material concerns, and Indian standards may be taken into account for the purposes of determining permissible height.

Third, if paragraph 8(a) does regulate freeboard, 17:04 then the presence of structures at the top of the dam, such as spillway bridges, but presumably other facilities as well, and the need to protect them from wave splash, justifies the further raising of the freeboard.

Now, Pakistan considers each of these propositions to be wrong to a greater or lesser extent.

So on India's logically antecedent position that paragraph 8(a) does not regulate freeboard, that's plainly wrong, for the reasons given by Professor Lafitte in Baglihar. If India were to insert stoplogs into the RHEP's gated spillway or add additional height to the spillway gates, the gap that that spillway relies on to render it paragraph 8(a)-compliant would be diminished or eliminated, and its operator could easily fill the operating pool above the full pondage level, breaching paragraph 8(a). Freeboard regulation minimises the potential for such abuse, and is therefore a logical and necessary element of paragraph 8(a).

On India's second position, that wind setup and wave run-up are material concerns when setting freeboard height, Pakistan agrees with the basic proposition. And I would add to that such other concerns as I mentioned, concerning type of dam, flood conditions, surcharge storage, reservoir operations, and so on and so forth.

17:05 But where Pakistan parts ways with India -- alluding to Mr Minear's point -- is with India's reliance on standards that it sets itself. These are within the unilateral control of India and cannot be the sole basis of its position.

Now, Pakistan isn't necessarily hostile to Indian standards, but it would hope and expect that the Indian standard would be corroborated by an accepted international benchmark -- be it ICOLD, US Army Corps of Engineers, US Bureau of Reclamation -- before that standard, the Indian standard, could constitute an objective metric by which freeboard could be assessed.

Then on India's third position, that structures on top of the dam may justify an increase in freeboard height, Pakistan disagrees with this position. In no international standard of which Pakistan is aware are such concerns considered material. The reason for this is that freeboard is intended to guarantee the safety of the dam as a whole. It is not intended to improve the longevity of additional structures such as bridges by preventing them from getting wet.

This is, a fortiori, moreover, in circumstances where multiple Treaty-compliant workarounds are available to India. You're concerned about the spillway

17:06 bridges eroding? Build them out of concrete like the rest of the dam. Still worried about the few remaining metal components? Provide proper coatings and undertake proper maintenance and repair. Still -- for reasons that pass understanding -- concerned about the longevity of the bridge? Move the beams out of the way so that they are no longer submerged.

Put simply, India's design convenience does not allow it to increase the height of its Western Rivers HEPs' freeboard.

Paragraph 8(a), as I have demonstrated, is intended to place firm limits on India's capacity to store the waters of the Western Rivers. This is consistent with the controlling injunction of Article III generally, and the deep suspicion of storage reflected in Article III(4).

India's choice of bridge design at the RHEP, or any other site for that matter, does not trump Pakistan's rights under Article III, which rights form the essential gravamen of the Treaty so far as the Western Rivers are concerned, as Professor Webb has shown. And the fact that India is driven to argue in multiple meetings of the Commission that its design convenience does trump Article III shows, with respect, the poverty of its position.

17:08 (Slide 36) I think I can leave India's position there and turn now to the final part of Pakistan's position on freeboard: providing an answer to the Court's question.

(Slide 37) We've come full circle. It's now back on the slide for you:

"With respect to Annexure D, paragraph 8(a), what is to be taken into account for the purposes of designing the freeboard of a plant and what is to be excluded?"

(Slide 38) You'll recognise this diagram, or at least the format.

The first part: what is to be taken into account? I've already answered this. It is the safety factors I have mentioned earlier, as defined by reference to the applicable international standards. And these reflect the serious and material safety concerns that freeboard is intended to address; concerns that, if not appropriately weighed, can endanger the dam itself, and everything and everyone downstream.

So just to remind you of what they are -- you've got them on the slide -- type of dam, type of spillway, need for flood surcharge, flood conditions, wind and wave conditions, seismicity, geological conditions, reservoir operations. And all of this is under the umbrella of the first item, which is the need to minimise freeboard

17:09 within safe limits.

Now, despite their seriousness, when dealing with a concrete dam, this will usually result in a fairly limited freeboard. Again, I recall in this respect the Bureau of Reclamation's guidance that a concrete dam will, as a default, require only a 1.1-metre parapet wall by way of freeboard.

But turning now to the second part of the Court's question: what is to be excluded? The obvious answer is: anything that is not expressly included or required by necessary implication. But a more specific answer could be: any factor not intended to guarantee the safety of the dam as a whole; and in particular, considerations arising from structures that India wishes to situate atop the dam. If India does want to build such structures, it can select designs approaches that are Treaty-compliant. Paragraph 8(a) does not exist to service India's design convenience.

Members of the Court, thank you for bearing with me. This concludes Pakistan's submissions on paragraph 8(a) of Annexure D and the question of freeboard. Unless you have any further questions for me or I can assist you further, those are my submissions.

Professor Buytaert.

THE CHAIRMAN: Professor Buytaert.

17:10 (5.10 pm)

Questions from THE COURT

PROFESSOR BUYTAERT: Thank you, Dr Miles. If you could perhaps go back to your previous slide (38); I think that's the best one to illustrate.

My question is: if India were to argue that climate change affects a lot of these factors and introduces an additional factor of uncertainty that requires, for example, a larger freeboard, would that be a relevant factor for Pakistan; and if so, where in this graphic or in this schema would that come in?

DR MILES: Speaking, as always, under the control of my engineering colleagues, I believe that would probably come into flood conditions, which are already included there. You may see a situation in which you see slightly larger floods in climate change times, and that would need to be included. So I think it's already included in the matrix here.

PROFESSOR BUYTAERT: Thank you.

THE CHAIRMAN: Okay, I think we don't have any further questions. Thank you, Dr Miles, very much for your presentation.

DR MILES: Thank you, sir.

THE CHAIRMAN: So, Sir Daniel, we originally had you on for saying something at the end of the day, but I thought

17:11 I heard you earlier say perhaps you would hold off till tomorrow. So what's your preference?

SIR DANIEL: Mr Chairman, if we can get it done today, I think it would be useful to do so. My submissions I think are around 20 minutes, maximum 25 minutes. We've got time to do it tomorrow. So it really depends on whether there is a guillotine at 5.30 precisely or whether you will allow me a couple of minutes if I go over.

THE CHAIRMAN: I don't think it's a problem to go a couple of minutes over, so I would say let's go ahead and proceed.

SIR DANIEL: Thank you.

(5.12 pm)

Submissions on Situating the Calculation of Pondage within the Scheme of the Treaty

SIR DANIEL: Thank you very much, Mr Chairman, members of the Court.

Before we end the day, I would like just to make some brief remarks on the subject of pondage, really to build a bridge to the submissions that we will hear from Dr Miles tomorrow on the subject. And you will have him on his feet for two and a half-plus hours in the morning and then he'll be back just after lunch to address you on your written questions relating to the redesign of

17:13 the Neelum-Jhelum plant and the Baglihar plant. So this is really a bridge to his day tomorrow.

I note also that unless, Mr Chairman, you signal that you are entirely satisfied with what you hear both from me now and from Dr Miles tomorrow on the subject of Pakistan's case on pondage in the Baglihar proceedings, we will come back to this in closer detail next week, as it has certainly been evident from your questions over the course of the last few days that the Court has some interest in the change, the modification in Pakistan's approach to the methodology of the calculation of maximum allowable pondage that Pakistan has advanced in these proceedings and the approach that it advanced in the Baglihar case.

So if you wish to give us a steer after Dr Miles tomorrow as to whether we've satisfied your curiosity or you'd like us to come back with greater detail, that would be very helpful.

Now, I'll come back to this modification in methodology in just a moment. But I'd like to begin, though, with Professor Buytaert's concluding question to Mr Rae yesterday, which provides a useful way into the subject of pondage.

Professor Buytaert, you put the following question to Mr Rae yesterday, and I'm quoting from the

17:14 transcript, Day 3, page 106, lines 8 to 14. You said:

"So you very clearly sketched the evolution towards more renewables. How would the design of a plant and pondage in particular -- or how does that inform the calculation of pondage? Is there any established methodology to deal with the inevitable uncertainty of future changes in demand and variability?"

That was your question. Mr Rae responded as follows:

"I would say this is an area which is changing extremely rapidly within the industry, and there is a lot -- so I can't say that there's any one accepted methodology yet. I would say that it's changing so dynamically that almost month by month, people are coming up with different ideas of how to do this."

And that's transcript Day 3, page 106, lines 15 to 20.

Mr Rae then went on to give a fuller explanation of the issues associated with undertaking a pondage calculation in which, as he put it, you are "trying to match variable power with variable production" in circumstances in which one is trying to "match pondage with an eco-flow study". And this is at transcript Day 3, page 107, lines 1 to 14.

Now, this question and answer at the end of Mr Rae's

17:16 submissions followed earlier submissions by Mr Rae in which he was careful to explain that, in contrast to the normal use of the terms "Pondage" and "Firm Power", as he was discussing them:

"... critically, the Indus Waters Treaty adopts a specific formula that simplifies this computation of the firm power by establishing the flow rate that will be used to calculate the firm power. And this simplification allows for the definition of firm power without resorting to a generation planning analysis or any other assumptions. So effectively it has removed this process from being under the remit of the Treaty."

That's transcript Day 3, page 75, lines 3 to 10,.

Mr Chairman, members of the Court, this provides a useful platform for me to make some initial framing observations for the submissions to come from Dr Miles on pondage.

The key terms in the Treaty addressing pondage and the calculation of maximum allowable pondage are given a special meaning in the Treaty, being used in a Treaty-specific way that is entirely different from the way in which these terms are used in normal engineering practice. And I think you've heard this from me in overview previously, I think it's also a topic that Professor Webb has addressed, and Dr Miles

17:17 will come back to this in a great deal of detail.

For reasons of time, I won't ask you to turn these up again now; and you will, in any event, already be familiar with them. But you may nonetheless, in advance of Dr Miles's submissions tomorrow morning on pondage, like to refresh your memory of the definition of the term "Firm Power", which is given in paragraph 2(i) of Annexure D, and the meaning given to "Pondage" in paragraph 2(c). There's also the meaning given to "Dead Storage" and "Dead Storage Level" at paragraph 2(a), and the formulation of the design criterion in respect of the maximum allowable pondage in paragraph 8(c). There are other pertinent provisions that will be important, but these are the key ones.

So going back to Mr Rae's submissions of yesterday, which I've just read out to you, he said -- and I read his statement again -- he said:

"... critically, the Indus Waters Treaty adopts a formula that simplifies this computation of the firm power ..."

That's the computation for firm power in paragraph 2(i) of the Treaty:

"... by establishing the flow rate that will be used to calculate the firm power. And this simplification allows for the definition of firm power without

17:19 resorting to a generation planning analysis or any other assumptions. So effectively it has removed the process from being under the remit of the Treaty."

Now, Mr Rae put his finger on a number of important points in this exchange and brief statement. First, the key terms of the Treaty, in particular with regard to pondage and the calculation of the maximum allowable pondage, are given special meanings. Second, the purpose of these special meanings is to address the possibility of uncertainty arising in respect of the meanings given to these terms that might otherwise result from normal engineering usage. And third, flowing from this, the purpose of the special meanings is to reduce complexity and to simplify the definition for computational purposes. And this is also going to be relevant when I come to explain the very slight modification in Pakistan's position.

As Mr Rae said, with respect to the definition of firm power, which is at the very heart of the calculation of pondage -- the calculation of pondage in 8(c) refers back to firm power, as you'll recall -- firm power under the Treaty is tied to the flow rate of the river. This makes the calculation that is required for the calculation of firm power much more straightforward than it might otherwise have been.

17:20 Now, I'm not going to invite you to cross-examine me on these issues now, because Dr Miles will unpack this further in his submissions tomorrow. The points with which I'd like to leave you from this excursus into the exchange with Mr Rae are three.

First, his observation on the rapidly changing dynamic with regard to the calculation on pondage in the case of non-Treaty issues does not apply to the approach of the Treaty to the calculation of pondage. That dynamic change that he was referring to does not apply in the case of the Treaty. Second, as Mr Rae emphasised, the Treaty accords special meaning to the key terms with which we are concerned. And third, the special meanings are intended to and have the effect of simplifying the calculation that was required.

Mr Chairman, members of the Court, I'd like to move on to make some brief observations on the issue of the dispute with respect to pondage and the change in Pakistan's method of calculation from its Baglihar submissions to the method of calculation that we have put forward in the Memorial in these proceedings.

Mr Chairman, as I go through this list, if there are issues that we have misperceived, or there are other issues in your minds on this point, please do identify them for us. But as we apprehend it, there are four

17:22 issues that arise with respect to the Baglihar enquiry that you have articulated so far.

They are, first of all: is the dispute of which you are seised the same dispute expressed in Pakistan's Request -- now its Amended Request -- for Arbitration? We're not quite sure whether that is one of the issues in your mind or whether we are misperceiving it on our side of the podium.

Second, what is the reason that pushed Pakistan to modify the methodology of its calculation from that advanced in the Baglihar proceedings?

Third, what implications does this modification of methodology have for Pakistan's case in these proceedings?

Then fourth, what are the technical details of the pondage calculation that Pakistan advanced in the Baglihar proceedings as a learning exercise, if I can put it in those terms?

That's the universe of points of enquiry that we've taken from your questioning of us over the course of the last few days.

I will begin a discussion on these issues, but I'm only going to respond, certainly at the moment, on the first three questions. I will not step into the technical issues of the calculation at the heart of

17:23 Pakistan's Baglihar submissions. If you would like us to go into these issues, we will happily do so next week.

Then I pause here just to say that although I and we anticipate that this is not what is driving your enquiry, if you consider that, for competence reasons, you should be seised of the technical detail of Pakistan's methodology that was used at the point at which Pakistan filed its Request for Arbitration on 19 August 2016, we can include our contemporaneous computational methodology as part of our final submissions and address them to you in detail next week, just to shine a light a little bit more brightly on that.

We are not entirely sure whether your questions about Baglihar methodology are being driven by an interest relating to competence, or whether it's a question that is being driven by an interest in knowing what our methodology was and why it changed, so that you can better inform yourself when you come to undertake that computation.

THE CHAIRMAN: Perhaps I'll just note that I believe our interest was the latter and not the former. I don't know whether perhaps Pakistan connected the questions relating to competence to this issue, but that wasn't,

17:25 I think, our intention.

Our intention, in terms of competence, was simply to try to understand: when Pakistan believes that a prior decision of the Neutral Expert is or is not binding, we were attempting to understand whether it mattered whether it had been appealed or not appealed. And we were not, in that context, thinking back to the Baglihar Neutral Expert determination with respect to our own competence.

SIR DANIEL: Thank you very much, Mr Chairman. I think that that's very helpful, and it may make some of what I'm about to say a little bit beside the point. I'll make them in any event, just for completeness. I think we had understood it the way that you have just explained it, but we wanted to make sure that we were not misunderstanding.

What may, though, be interesting and useful and illuminating to you, before I come to address the slight modification in methodology, is to compare the various pondage values in respect of the Baglihar plant that were advanced in and subsequent to those proceedings, to actually get a sense of what the changing computational methodology actually led to or would achieve.

So first of all, going into the Baglihar proceedings, India's calculation advanced as part of its

17:26
case in Baglihar was for a maximum pondage of 37.722 million cubic metres. Pakistan's calculation, going into the Baglihar proceedings, advanced a case for a maximum of 6.22 million cubic metres. That was the big divide between India and Pakistan at the same time.
The Neutral Expert's determination in the Baglihar case settled on a maximum allowable pondage of 32.56 million cubic metres, so slightly less than that advanced by India. India was 37.722; the Neutral Expert settled on 32.56. So slightly less than India's, but not by much, but still significantly at odds with that advanced by Pakistan.
As Dr Miles will address, the Neutral Expert in Baglihar varied India's calculation methodology marginally. And following the Baglihar determination, India has adopted the Neutral Expert's approach, which it maintains today.
On the basis of Pakistan's simplified calculation of maximum allowable pondage that we have put before you in these proceedings, advanced in the Memorial, the Baglihar maximum pondage would have been 5.43 million cubic metres, and that's a contrast to 6.22 as we advanced it in our Baglihar submissions. In other words, it was a little bit less: broadly the same, a little bit less, but not by much. But it was

17:28
significantly at odds both with India's initial calculation and with the Neutral Expert's determination, which India has now adopted.
So this then brings me to the first of my issues: is the dispute of which you are seised the same dispute expressed in Pakistan's Request for Arbitration? And the answer is unequivocally yes. And I expect that you will have this very much in mind, because when you addressed in your Competence Award the evolution of the dispute, you addressed many of these exchanges.
As I mentioned yesterday, this was addressed expressly in paragraphs 11.1 to 11.4 of Pakistan's Memorial. In the interests of time, I don't propose to read these into the record, but you will find the issue addressed succinctly at that point.
The key takeaway is that the contours of the parties' respective positions on the calculation of pondage, and what is relevant for purposes of that calculation and what is excluded, are essentially unchanged over the years. India does not conceive of its right to generate hydroelectrical power as an exception to Pakistan's right of unrestricted use.
India also draws on the definition of "Pondage" in paragraph 2(c) for purposes of its calculation, and on the operational provisions in paragraph 15. It draws

17:30
2(c) and paragraph 15 into the calculation of maximum allowable pondage, while using the installed capacity of the plant.
Pakistan, on the other hand, considers that the paragraph 8(c) criterion is the critical provision, and that incorporates the definition of "Firm Power" in paragraph 2(i); and that the operational constraints of paragraph 15 must be referred to only for the purpose of assessing whether the HEP will be capable of working within the prescribed design criteria.
The constant element in Pakistan's position has been that the pondage is to allow the plant to operate at firm power. So there is a very clear divide in the methodology that Pakistan and India have been deploying or resorting to over the years.
The parties are also in dispute about the relevance of load to the calculation of pondage. India says that it is entitled to a level of pondage that will enable them to meet the demand requirements of the Indian electricity grid, and that portion of the load that they wish to place on the particular HEP in question; one of the reasons why we've been so interested in the questions from the Court on load.
Pakistan contests this approach. As both Dr Morris and Mr Rae explained, the bespoke definition of "Firm

17:31
Power" ties the calculation of pondage to the hydrology of the river, not to the demands of India's electricity grid.
So once again, we have a very stark divide between the parties.
And indeed, if it was tied to the demands and the variability of demand of India's electricity grid and the HEP's place within it, our concern is that India would be able to manipulate the pondage calculation as it saw fit.
In addition, as Ms Rees-Evans explained at the end of her presentation on Tuesday, the evolution of the Treaty drafts on this point supports a clear move away from the relevance of load as part of the pondage design criterion. And I think that was some of the exchanges between Ms Rees-Evans and Mr Minear.
That the dispute that is addressed in Pakistan's Memorial is the dispute of which you are seised by Pakistan's Request for Arbitration is also demonstrable by reference to the formulation of Pakistan's objection to India's approach to pondage from its very inception, in 1992, in the context of the then proposed Baglihar plant, all the way through to its statement of objection in the Request for Arbitration, to the way in which it is addressed in Pakistan's Memorial.

17:33 I won't take you to any of the documents, but I drew your attention yesterday, if I recall correctly -- time has gone in a little bit of a blur -- but I drew your attention to Pakistan's objection to India's Baglihar proposal on 12 August 1992. That was an exchange of correspondence from the PCIW to the ICIW. This is Exhibit P-0586. And this was the point at which Pakistan first set out its objection to India's methodology for the calculation of pondage.

As I say, I won't take you to that, in the interests of time, but I do refer you to paragraph 5 of that letter, the 1992 letter. And as you will see when you turn it up, that letter puts forward Pakistan's objection to India's approach to pondage in terms that could simply have been cut-and-pasted into Pakistan's Memorial in these proceedings. So from that point, in August 1992, until today, 32 years later, there has been a consistency in Pakistan's view, and indeed a consistent opposition of the parties on the question of methodology.

So what this shows is that the dispute between Pakistan and India on this point is not a dispute over the fine detail of the calculation but a far more fundamental dispute concerning the actual premise of the calculation itself. In other words, the dispute is

17:34 whether the basis of the pondage calculation is "Firm Power" within the meaning of paragraph 8(c) and paragraph 2(i) of Annexure D, as Pakistan contends, or whether the calculation must take into account the need to meet a fluctuating load on the plant, rooted in paragraph 2(c) and paragraph 15 of Annexure D, as India contends.

This dispute persisted through the Baglihar Neutral Expert determination process and in exchanges between the Commissioners in the PIC subsequently. It is also expressed in Pakistan's Request -- now its Amended Request -- for Arbitration, in particular at paragraphs 47 to 56, and paragraphs 63 to 64. So once again, you can see a golden thread running from 1992 in the exchanges between the parties on this question of the calculation methodology.

This brings me to my second issue, which is: what is the reason that pushed Pakistan to modify the methodology of its pondage calculation from that which it advanced in the Baglihar proceedings? And I note, first of all, that there is only a relatively small modification in Pakistan's methodology of calculation in respect of the operating presumption in respect of which firm power should be presumed for purposes of the calculation.

17:36 In the Baglihar case -- and I appreciate that the Court already has this, because it's evident from the questions that you put to us -- but in the Baglihar case, Pakistan premised its operationalisation of paragraph 8(c) on the idea that it required pondage sufficient to allow for constant firm power; in other words, firm power for 24 hours a day, 7 days a week. That was the basis of the calculation that Pakistan advanced at that stage: 24 hours, 7 days a week, constant firm power.

After Baglihar, as one would expect, Pakistan went back to the drawing board; and more particularly, in the context of the preparation for these proceedings, which had been paused for all of those years, and Pakistan concluded that there was too much complexity in the calculation that it had advanced previously, and too much variability in the outcome of the calculation, to make it a sensible approach to the calculation of maximum allowable pondage under the Treaty. And given this appreciation, Pakistan modified the methodology of calculation, informing its revised approach both by a legal interpretation of the construction of the Treaty as well as an engineering appreciation.

Just to illuminate this a little further, I note that one of the challenges with the position that

17:38 Pakistan advanced in the Baglihar proceedings was that it did not produce a fixed and unique pondage figure for each HEP. Rather, it produced a range of possible numbers from which a correct figure then had to be selected.

As you will have seen from our Memorial, and as Dr Miles will address with you in some very precise detail, one of the driving considerations that we have concluded needs to be at the heart of the calculation of pondage is that it needs to come up with a number certain for each HEP. Otherwise it just introduces complexity, uncertainty and dispute.

There are other reasons for preferring our modified approach to the calculation, which I need not go into now, but we'd be happy to do so. It may be that Dr Miles will touch upon them in the course of his submissions tomorrow; otherwise we would be happy to do so and come back to them in detail next week.

So this brings me -- and I'm about to conclude -- but it brings me to my third issue, namely: what implications, if any, does this modification in Pakistan's approach have for the calculation of maximum allowable pondage in these proceedings?

The short answer, Mr Chairman, members of the Court, is that it has no implications, as you have before you, 17:39 in Pakistan's Memorial, Pakistan's best and most carefully considered statement of what it submits is the correct approach to the calculation of maximum allowable pondage under paragraph 8(c).

I add that in reaching this view, Pakistan, together with its internal and external engineering teams and its internal and external legal teams, looked again at every possible approach that we could possibly conceive of, including that advanced by India and that adopted by the Baglihar Neutral Expert, for purposes of coming up with what Pakistan would consider to be the most compelling approach to the interpretation of paragraph 8(c). We've been very conscious that what we were addressing you on in writing in the Memorial and what we are addressing you on now orally and what we are asking of you is a systemic interpretation of 8(c). And particularly with the absence of the Respondent, we took it as a guiding principle that we needed to be as rigorous and as transparent as possible in coming up with our calculations.

Now I come back to, as it were, the offer that I made at the beginning, and with this I will close. If, Mr Chairman, members of the Court, you would like us to address the technical detail of the Baglihar calculation in the second round, we would be happy to do

17:40 so. We would have to work it up, but we have the means to do so, and I anticipate that we would have the time to do so. So if you would find it illuminating or informative for purposes of the calculation that you have to undertake, we'd be very happy to do that next week.

That brings an end to my submissions, and thank you for allowing them to go on at this point, because I think it's a useful bridge to Dr Miles tomorrow.

THE CHAIRMAN: That's fine, Sir Daniel. Let me just check to see if I have any questions from -- no questions.

I will say I think that it was a very helpful explanation you gave. And certainly for my part, I take the point that the general approach of Pakistan to calculation of pondage has been consistent, and that it's more perhaps the fine detail that has changed over time.

I'll be interested in hearing the presentations tomorrow. To the extent that you're able to at least say a little bit about how, if you were to take your current approach for calculation of pondage and modify the fine detail to a seven-day approach, whether that changes it in any significant way. It sounds like, from what you said, it wouldn't: that for Baglihar, it wouldn't make much of a difference. And if that's true

17:42 generally speaking, it just would be interesting to hear perhaps a little bit more about that.

But I'll let you think about that and look forward to the presentations tomorrow.

SIR DANIEL: I'm sure Dr Miles will be able to address that. And to the extent that there are any dangling elements to that, we can come back to that next week.

THE CHAIRMAN: Very good. In which case I think we are done for the day and we will see you again tomorrow morning at 9.30.

SIR DANIEL: Thank you very much.

THE CHAIRMAN: Thank you.

(5.43 pm)

(The hearing adjourned until 9.30 am the following day)