

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
(SITE VISIT)

COURT OF ARBITRATION:

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

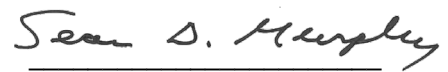
SECRETARIAT:

The Permanent Court of Arbitration

ON BEHALF OF THE COURT OF
ARBITRATION:

CERTIFIED PURSUANT
TO
PARAGRAPH 19 OF ANNEXURE G

24 April 2024



Professor Sean D. Murphy
Chairman

Arbitration pursuant to Article IX and Annexure G
of the Indus Waters Treaty 1960

Pearl Continental Hotel
Muzaffarabad
Pakistan-administered
Kashmir and Jammu Region

Day 2
Site Visit to the NJHEP

Wednesday, 24th April 2024

Before:

PROFESSOR SEAN D MURPHY
PROFESSOR WOUTER BUYTAERT
MR JEFFREY P MINEAR
DR DON BLACKMORE

MR STEPHEN POMPER, NEUTRAL OBSERVER

BETWEEN:

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

Transcript produced by Lisa Gulland and Trevor McGowan

APPEARANCES

FOR THE ISLAMIC REPUBLIC OF PAKISTAN

MR RAJA NAEEM AKBAR, Ministry of Law and Justice
MR SYED ALI MURTAZA, Ministry of Water Resources
MR SYED MUHAMMAD MEHAR ALI SHAH, Commissioner for
Indus Waters
Mr ILYAS MEHMOOD NIZAMI, Ministry of Foreign Affairs
MR SOMEIR SIRAJ, Office of the Attorney General for Pakistan
MS ZAINAB MALIK, Office of the Secretary of Law and Justice
SIR DANIEL BETHLEHEM KC, Twenty Essex, London
PROFESSOR PHILIPPA WEBB, Twenty Essex, London
DR CAMERON MILES, 3 Verulam Buildings, London
DR GREGORY L MORRIS, Technical Advisor
MR PETER J RAE, Technical Advisor

THE REPUBLIC OF INDIA WAS NOT REPRESENTED

SITE EXPERTS

MR MUHAMMAD AZAM JOYA, Pakistan Water and Power Development
Authority (WAPDA)
MR USMAN-E-GHANI, Additional Commissioner for Indus Waters
DR TAHIR MAHMOOD HAYAT, Diamer Basha Consultants Group
MR MUHAMMAD ARFAN MIANA, Neelum Jhelum Hydropower Company
(NJHPC)
MR MUHAMMAD AYUB MALIK, NJHPC
MR NAYYAR ALAUDDIN, NJHPC
MR MUHAMMAD UMAR FAROOQ, National Engineering Services
Pakistan (NESPAK)
MR FIAZ HANIF SENDHU, Tarbela 5th Extension Project
MR ARSHAD MALIK, WAPDA
DR YASIR ABBAS, NESPAK
MR MUHAMMAD TARIQ, Tarbela 4th Extension Project
MR HAMEEDULLAH KHAN, Warsak Hydro-Electric Project

FOR THE PERMANENT COURT OF ARBITRATION

MR GARTH SCHOFIELD, Deputy Secretary General
MR BRYCE WILLIAMS, Legal Counsel
MR SEBASTIAN KING, Assistant Legal Counsel
MR DAAN NIEUWLAND, Videographer

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1 Wednesday, 24 April 2024
 2 MR JOYA: Good afternoon, everyone, Chairman Murphy and
 3 members of Court of Arbitration. My name is Muhammad
 4 Azam Joya, and I am General Manager of Pakistan Water
 5 and Power Development Authority, known as WAPDA.
 6 In that capacity, it's my pleasure to welcome you
 7 and the wider delegation from the Permanent Court of
 8 Arbitration to Muzaffarabad for what will hopefully be
 9 an informative site visit of WAPDA's Neelum Jhelum
 10 hydropower plant -- known as NJHEP -- afterwards.
 11 I'm speaking in the place of Lieutenant General
 12 Sajjad Ghani, Chairman of WAPDA, who unfortunately was
 13 unable to be with us today due to some urgent and
 14 unavoidable business.
 15 Assisting me in this introductory presentation is
 16 Mr Usman-e-Ghani, Additional Pakistan Commissioner for
 17 the Indus Waters. I think he is here on the second
 18 seat.
 19 By way of background, WAPDA is one of Pakistan's
 20 largest and oldest government agencies, created by
 21 Pakistan Water and Power Development Authority Act 1958,
 22 it's headquartered at Lahore. It's a public utility in
 23 charge of developing, maintaining and managing
 24 publicly-owned hydropower facilities in Pakistan.
 25 At the present point in time, WAPDA controls some 23

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1 hydroelectric plants, or HEPs, with a total installed
 2 capacity of 9,476 MW. By 2028, we hope to add a further
 3 9,000 MW of hydropower to the national grid through
 4 megaprojects like Tarbela 5th Extension, Diamer Basha
 5 dam, Monmouth Hydroelectric Power Projects, and
 6 elsewhere as well.
 7 It is an exciting time for us, and we hope that you
 8 will feel some of the excitement in the course of your
 9 visit.
 10 Slide 2. The parameters of site visit as directed
 11 in your Procedural Order No. 10 are reflected, for the
 12 record, on the slides. It has been important for all of
 13 the site experts who will be making presentations to you
 14 to understand these parameters.
 15 Sir, we all are engineers, not lawyers. And
 16 perhaps, with some exceptions here and there, we have no
 17 knowledge or familiarity with the details of the dispute
 18 between Pakistan and India that has brought you here for
 19 the site visit. Nor are we knowledgeable about the
 20 Indus Waters Treaty. Rather than discuss these matters,
 21 and mindful of the directions given in your Procedural
 22 Order No. 10, we have come here to prepare to talk to
 23 you about the design, construction and operation of HEPs
 24 in our part of the world in a relative ignorance of how
 25 these issues may be relevant to your task.

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1 We understand that our task is to assist you in
 2 getting a better feel for the reality of HEP design,
 3 operation, by seeing a run-of-river plant in the flesh,
 4 through the lens of one such Pakistan plant, the NJHEP.
 5 Having said this, you should please feel free to ask
 6 us questions as we go along. I cannot promise that we
 7 will be able to answer everything that you may ask. And
 8 we say so: if we cannot, please don't hesitate to ask.
 9 WAPDA has accepted this mission with utmost
 10 seriousness, and has assembled from around Pakistan
 11 an array of leading experts in geology, hydrology,
 12 geography, design and power systems, as well as various
 13 branches of engineering, to discharge it.
 14 Slide 3. It remains only for me to introduce you to
 15 the NJHEP itself. It is one of WAPDA's proudest
 16 achievements: a 969 MW run-of-river HEP, sitting
 17 44 kilometres outside of Muzaffarabad, where we are
 18 right now. The NJHEP was designed and built between
 19 2008 and 2018. It now contributes 5,150 GWh of clean
 20 and reliable energy to the national grid every year. So
 21 it is a test bed for many similar HEPs that WAPDA wishes
 22 to develop in this region.
 23 Over the course of the next few days, you will
 24 become very familiar with the NJHEP and, through it, the
 25 process by which a run-of-river hydroelectric plant is

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1 built and operated in these Himalayas rivers. The
 2 entire facility is at your disposal and, should you wish
 3 to inspect any element of it, you have only to ask for
 4 it, sir.
 5 Thank you very much. I now turn the floor over to
 6 Chairman Murphy for any remarks you wish to make, sir.
 7 THE CHAIRMAN: Thank you very much, Mr Joya, for those
 8 welcoming remarks. I will say a few words on behalf of
 9 the Court of Arbitration. But before I do that, perhaps
 10 I will allow the members of the Court of Arbitration to
 11 introduce themselves.
 12 My name is Sean Murphy. I am the Chairman of this
 13 Court of Arbitration. I'm also a Professor of
 14 International Law at George Washington University in
 15 Washington DC. So to the extent that my questions are
 16 very simplistic, coming from a non-engineer, you'll
 17 understand why that's the case.
 18 Mr Minear, would you like to introduce yourself?
 19 MR MINEAR: Thank you, Sean. My name is Jeffrey Minear.
 20 I'm from the United States, and my training is as
 21 a lawyer. I'm here as a legal umpire on the Court of
 22 Arbitration. I also have training in natural resource
 23 management and as a chemical engineer, and I'd like to
 24 thank you at the outset for taking the time to share
 25 your knowledge about the facility with us. I look

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1 forward to learning a good deal today and in the days
 2 ahead.
 3 THE CHAIRMAN: Mr Blackmore.
 4 DR BLACKMORE: Thank you. My name is Don Blackmore. I'm
 5 a civil engineer. I used to run a water business in
 6 Australia that covers an area just a bit bigger than
 7 Pakistan, about 1 million square kilometres, and have
 8 owned and managed a number of hydroelectric plants in
 9 the past. I was a commissioner on the World Commission
 10 on Dams that looked at the development and effectiveness
 11 of the 50,000 large dams on earth, so I've seen dams in
 12 every setting, in every continent, bar Antarctica: they
 13 didn't invite me to Antarctica. So I bring an interest
 14 in what you've done with this dam, and I will listen
 15 with great interest, so thank you.
 16 THE CHAIRMAN: Professor Buytaert.
 17 PROFESSOR BUYTAERT: Thank you very much. Good afternoon,
 18 everyone. My name is Wouter Buytaert. I'm a Professor
 19 in Hydrology and Water Resources at Imperial College
 20 London.
 21 In case you wondered about my accent, I'm originally
 22 from Belgium, but I've been based in London for now 15
 23 years. I'm an environmental engineer by training, and
 24 have worked several decades already on mountain
 25 hydrology in particular, but all over the world: a long

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1 All the way at the end of the table is Mr Garth
 2 Schofield. He is the court's registrar, and he is also
 3 the Deputy Secretary General of the PCA.
 4 Mr Bryce Williams is over there, just raised his
 5 hand. He is the court's treasurer, also a member of the
 6 staff of the Permanent Court of Arbitration, and is
 7 assisting generally in the arbitration.
 8 And then Mr Sebastian King, here on my right, from
 9 the PCA staff.
 10 So those are the individuals who are helping
 11 administer the arbitration.
 12 We also have, as a part of the court's delegation, a
 13 videographer, who is standing behind the camera there,
 14 Mr Daan Nieuwland. He will be taking the video
 15 throughout the course of the visit.
 16 And then we have a person who is serving as the
 17 Neutral Observer. That's Mr Stephen Pomper, towards the
 18 end of the table there. He is an individual who works
 19 at the International Crisis Group, although he is acting
 20 here in his personal capacity. And I'll say a little
 21 more about the Neutral Observer in just a minute.
 22 So let me, first of all, thank the Government of
 23 Pakistan for organising this site visit. The Court of
 24 Arbitration is extremely grateful to you and to all of
 25 the site visit experts, who we know have already put in

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1 history in South America, but to a lesser extent also
 2 here in this part of the world. So I'm particularly
 3 interested in the broader hydrological/geomorphological
 4 setting of the dam, and the way that the engineering
 5 design has adapted to these settings.
 6 I really look forward to the visits, and thank you
 7 very much already for all your input.
 8 THE CHAIRMAN: There is a fifth member of our Court of
 9 Arbitration who is not present here, Judge
 10 Awn Al-Khasawneh. He is unable to be present for
 11 reasons that have been made known to the parties. And
 12 while that is regrettable, we are not, as a Court of
 13 Arbitration, taking any decisions in the course of this
 14 site visit, other than what may be necessary to deal
 15 with the logistics of the visit itself.
 16 Moreover, the video of the site visit that's being
 17 taken, and the transcript that will be made from the
 18 video, will be made available to him so that he can
 19 benefit from all of the presentations you'll be making,
 20 the questions we ask and your responses to them.
 21 I'd also like to introduce three members of the
 22 Court of Arbitration, which sits in The Hague, and is
 23 the body that administers the arbitration that we're
 24 involved in. We have three members from that Permanent
 25 Court of Arbitration.

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1 a lot of work in preparing yourselves for the next
 2 few days. That's evident from the various slides that
 3 you've prepared and shared with us in advance, and I'm
 4 sure will be evident in the presentations that you're to
 5 make in the next few days.
 6 We're very grateful also for all the logistics that
 7 has gone into this site visit. We know how difficult it
 8 is to arrange accommodations, transportation, security,
 9 the general well-being of those involved in the visit.
 10 It takes an awful lot of effort. We may not have
 11 security personnel in the room, but I hope that you will
 12 convey back to the security staff how grateful the Court
 13 of Arbitration is for their assistance as well.
 14 So I'll just quickly note that I know there are
 15 a lot of different parts of the government involved in
 16 this. I do want to thank the Ministry of Law and
 17 Justice -- including Mr Akbar, the deputy agent -- for
 18 all of its efforts here; the Ministry of Water
 19 Resources, including Mr Murtaza, who I know has been
 20 involved here; Pakistan's Commissioner for Indus Waters,
 21 Mr Ali Shah. It's good to see you again, sir, and many
 22 thanks to you and your staff for the work here.
 23 From the Ministry of Foreign Affairs, Mr Nizami. We
 24 very much appreciate all that the ministry has done to
 25 make this site visit possible.

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1 We have several external counsel, led by Sir Daniel
 2 Bethlehem here. We are very grateful for all of the
 3 work you've put in to help bring this together.
 4 And I'm sure I'm missing individuals or parts of the
 5 government, but please take thanks from the Court of
 6 Arbitration to everyone who's had a part in this
 7 process.
 8 Let me also note, with regret, the absence of the
 9 Government of India at this site visit. The court would
 10 like to recall that it invited India almost a year ago
 11 to participate in the site visit process, and would have
 12 welcomed and benefited from its involvement in the
 13 process, both in reacting to presentations being made by
 14 the site visit experts here, but also we would have
 15 liked to visit sites in territory administered by India.
 16 We would have benefited from hearing presentations from
 17 India's site experts about their work and their dams,
 18 and so we hope that India will at some point decide to
 19 engage in this process. It would greatly assist the
 20 Court of Arbitration if they were to do so.
 21 I'll note something that the engineers don't need to
 22 pay attention to, but India has not indicated
 23 an intention to file a counter-memorial in our process.
 24 So the next step in our process is a hearing on the
 25 merits regarding what we call "phase 1 issues", which

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1 receive arguments on the application of facts to the
 2 law, including with respect to the interpretation or
 3 application of the Indus Waters Treaty. So all the site
 4 experts can rest assured: we are not asking you any
 5 questions about the law. We're solely interested in
 6 some of the facts relating to this particular dam site.
 7 My fourth point: all presentations by the site
 8 experts are intended to be succinct, neutral, solely
 9 technical in nature, and are presented by individuals
 10 who are not members of the Government of Pakistan's team
 11 or experts appearing before the court.
 12 Fifth, the court's questions to the site experts
 13 will be exclusively on technical matters presented, and
 14 we will not stray into any legal issues.
 15 Sixth, at any time during a technical presentation
 16 or after it, members of the court may have questions for
 17 the experts. So I hope you don't mind us occasionally
 18 interrupting you with something that we just don't quite
 19 understand, and we would welcome your response. I take
 20 the point that there may be some questions that you're
 21 not able to respond; that's entirely fine. Do your
 22 best, we expect nothing more than that.
 23 Seventh, once a technical presentation is completed,
 24 to the extent that Pakistan's deputy agent or lead
 25 counsel believes that it would be helpful to the court

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1 will be in mid-July. The court would certainly welcome
 2 participation by India in that hearing if they are able
 3 and willing to do so.
 4 I will also note that this site visit is not -- is
 5 not -- an ex parte visit. Under Article 10.4 of the
 6 Supplemental Rules of Procedure of the Court, a meeting
 7 is not ex parte if both parties are given the
 8 opportunity to participate in the meeting and one party
 9 voluntarily elects not to do so.
 10 Mr Joya, you mentioned a little bit about the
 11 protocols for the site visit, and I appreciate very much
 12 that it's been passed through to everyone involved.
 13 I would like to stress a few aspects of what's in our
 14 Protocol No. 10, and indeed I have ten aspects that
 15 I would like to emphasise.
 16 First, the purpose of this visit is to familiarise
 17 the court with general aspects of the design and
 18 operation of run-of-river hydroelectric plants along the
 19 Indus system of rivers.
 20 Secondly, and I suppose conversely, the purpose is
 21 not to establish facts specific to any Indian
 22 run-of-river hydroelectric dams.
 23 Third, the purpose is not to receive any legal
 24 arguments from Pakistan -- and I think you've already
 25 made that clear yourself, Mr Joya -- and also not to

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1 for a succinct and non-leading question to be put to the
 2 technical expert for purposes of clarification or
 3 correction, then the deputy agent or the lead counsel
 4 will direct the question to me, and the court will
 5 decide whether or not to pursue the matter.
 6 Eighth, Mr Nieuwland, our videographer, will be
 7 recording all site visit activities, to include when
 8 we're walking around the facilities. In the course of
 9 this visit, please give him room to operate so that he
 10 can do his job of recording everything that we are
 11 embarked on.
 12 After the visit is completed, a transcript will be
 13 produced from the video recordings. At the same time,
 14 our PCA team will be taking some still photographs
 15 during the course of the visit. If a party wishes to
 16 have a particular aspect of the visit captured by photo
 17 or video, please make that request to the Secretariat.
 18 Ninth, other than that -- the videographer and our
 19 PCA staff taking photographs -- no one should be taking
 20 videos or photographs during this site visit. After the
 21 site visit is completed, in due course the video
 22 recordings, transcript and still photos will be made
 23 available to the parties, with a process in place for
 24 corrections to the transcript.
 25 Tenth, my final point: outside of the orientation

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1 sessions and the technical presentations, the members of
 2 the court and the Neutral Observer on the one hand, and
 3 the representatives and site experts of Pakistan on the
 4 other hand, may exchange cordial greetings. But there
 5 shall be no substantive exchanges, either technical or
 6 legal in nature.
 7 Finally, let me return to the presence of Mr Pomper
 8 as our Neutral Observer. His task is to be present
 9 throughout the site visit, to observe the proceedings
 10 and the overall conduct of the visit. He will alert me
 11 during the site visit if he has concerns in that regard,
 12 in which case I will address the matter promptly. He
 13 will then certify, at the end of the site visit, that it
 14 was -- or was not -- conducted in accordance with the
 15 protocols set out in Protocol Order No. 10.
 16 Unless there are any further issues to be raised,
 17 the court is ready to receive the first presentation.
 18 (A short break)
 19 Presentation 1: NJHEP General Orientation
 20 MR JOYA: So I will now give you a short introduction of
 21 NJHEP, with a view to situating you for the
 22 presentations to come.
 23 Slide 5, please. On the slide, we have a map of the
 24 surrounding area, with major cities and hydropower
 25 features. I shall start from left of the site; that is

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1 Muzaffarabad. You can see Muzaffarabad over here. This
 2 is the place where we are right now.
 3 Muzaffarabad is the intersection of two rivers. One
 4 is called Neelum River, which is known as Kishenganga as
 5 well, by our Indian friends; and second is upper limb of
 6 Jhelum River, combines over here.
 7 Sir, if we follow the Neelum River upstream, we will
 8 reach the headworks of NJHEP over here; the triangle
 9 shows it. By "headworks", I mean the dam, its
 10 associated structures, together with the reservoir.
 11 So you can also see a tunnel over here from the
 12 headworks, which comes down to the Jhelum again. This
 13 tunnel is to generate the head of hydropower production,
 14 by which I mean it's a vertical distance between the
 15 reservoir and the turbines at the end. It removes water
 16 from Neelum River and discharges it back to the Jhelum
 17 River downstream of Muzaffarabad.
 18 Around the NJHEP, we see a grey line over here. It
 19 encompasses the catchment area of Neelum River.
 20 Catchment area means that this area feeds the Neelum
 21 River in its discharges. So these discharges ultimately
 22 help out to operate the NJHEP project.
 23 Furthermore, there is a red line as well. That's
 24 the line of control. If we see on other side of line of
 25 control, Indian territory, Indian-administered Kashmir,

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1 we see the Kishenganga project over there, with the
 2 yellow, which is functioning right there. And with
 3 their tunnel as well, it is performing a similar
 4 function as I told earlier in the NJHEP project.
 5 South of that is the upper limb of Jhelum River, and
 6 you can see Sirinagar as well. This Jhelum River
 7 discharges into and then emerges out of Wular Lake,
 8 located in India. And downstream of Wular Lake, you can
 9 see the Lower Jhelum project by India, the Uri 1 and
 10 Uri 2 projects.
 11 Once again, crossing the red line of control, we can
 12 see Siran over here, the red triangle. It is our
 13 forthcoming hydroelectric project which Pakistan is in
 14 process of constructing. And once more, you see a route
 15 of tunnel over here, which removes water from Jhelum
 16 Upper Limb, and discharges it back into the Jhelum again
 17 downstream of Muzaffarabad.
 18 Slide 6, please.
 19 THE CHAIRMAN: Mr Joya, before you leave this slide, can
 20 I ask you to point out on the slide where the power
 21 station is located.
 22 MR JOYA: So the NJHEP, we start from the headworks. The
 23 power station comes right after crossing the Neelum
 24 River -- Jhelum River right over here somewhere. That
 25 will come in detail later on, sir.

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1 THE CHAIRMAN: So it's right on that part of the river?
 2 MR JOYA: Yes, it's here.
 3 THE CHAIRMAN: And second question is: as we go up here
 4 along the river, I looked down at a certain point and
 5 I thought I saw what might be the tailrace. Is that
 6 possible or are we not in the right location?
 7 MR JOYA: In the coming slides, I will further bifurcate the
 8 tunnels, the headrace and the tailrace, with different
 9 colours and different details.
 10 THE CHAIRMAN: Okay. I may revisit my question.
 11 MR JOYA: Thank you. You really like questions, sir.
 12 Because all project -- 90% -- is underground, so to
 13 understand it is very nice.
 14 Slide 6, please. So let's now look a little more
 15 closely at NJHEP site. The headworks site is clearly
 16 marked with a triangle over here. And you can see the
 17 tunnel which comes out of that headworks from northeast
 18 to southwest. After coming out of the headworks, the
 19 tunnel splits into two different tunnels. Then after
 20 crossing the Jhelum River, as I told earlier, it
 21 recombines. And again, as a single tunnel, it enters
 22 into the power station, powerhouse. And from the
 23 powerhouse is the tailrace tunnel, which discharges
 24 water into the Jhelum River.
 25 These green tunnels we have to construct due to the

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1 poor geology of this area. So instead of going for
 2 a single larger [one] there, we have to go for two
 3 smaller ones, to cater for the geology of the area,
 4 based on recommendation of the designers.
 5 At the lower parts, you can see the powerhouse where
 6 the turbines and generators are located. And from
 7 there, as I told earlier, is the tailrace you can see at
 8 the bottom. It will come in more detail later on, sir.
 9 Slide 7. So it's about the headworks. On the slide
 10 I will explain three things. Number 1 is the reservoir;
 11 number 2 is the dam wall; and number 3, the Neelum River
 12 flowing from south to north. These things are coming in
 13 detail in the forthcoming slides, sir.
 14 Slide 8, please. Now I have tilted the previous
 15 slide at 90 degrees to give a more clear picture, sir,
 16 of the area. This shows the design in a little more
 17 detail with the key elements picked out. This image
 18 will be revisited in many presentations which will come
 19 after me by other presenters. It is included over here
 20 just to familiarise you with the orientation of the
 21 project.
 22 As I told earlier, it's the previous slide: it has
 23 been turned at a 90-degree angle. It shows the Neelum
 24 River flowing from left to right. And the dam wall is
 25 shown in yellow, and its associated structures in

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1 brownish over here.
 2 Then there are two spillways, shown in red and in
 3 purple. And dissipation structure, and you can see
 4 a brownish colour. Then you can see the stilling basin
 5 over here; the "desanders", it's called. It's
 6 a desander structure, with the structure which is shown
 7 in pink. It is the operating building. And then,
 8 finally, there's a headrace tunnel, which comes in
 9 purple.
 10 So it's the overall orientation of the project, just
 11 to show up the things, sir.
 12 Slide 9, please. You can see here, for the first
 13 time, the detail of the two spillways. The low-level
 14 orifice spillway is on right side, whereas on left side
 15 is surface level crest-gated spillway. These are the
 16 structures by which HEP passes floodwater through the
 17 dam. In its background, you can see the reservoir,
 18 which is stretching away towards southeast as
 19 (indistinct).
 20 Sir, foreground is denominated by these desander
 21 structures you can see over here. And at the very
 22 bottom of the desander structure, this one, it is
 23 a collecting canal which connects to headrace, which is
 24 somewhere over here. It goes in this way, sir, which
 25 I showed earlier in purple colour.

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1 Slide 10, please. It's another view from the
 2 downstream side, to make things for the completeness of
 3 purpose. From this angle, the orifice spillway is
 4 completely submerged into water over here, whereas you
 5 can see the crest-gated spillway over here; and these
 6 are its gates, which are operated over here.
 7 This image also gives a clear view of the freeboard.
 8 Freeboard is a structure extended above the surface
 9 level of the reservoir, you can see over here.
 10 Slide 11, please. There is more about NJHEP
 11 powerhouse site. Turning now towards the powerhouse,
 12 this is a satellite image of it, obviously not showing
 13 the powerhouse itself -- it is only denoted by a word
 14 "P" -- which is well below the surface.
 15 Same may be said to the headrace and tailrace, which
 16 run from top right to the bottom left. Running through
 17 the powerhouse, ultimately these enter into the Jhelum
 18 River to discharge water.
 19 What you can see, however, is the switchyard above
 20 the ground, to connect the power to our national grid
 21 from here.
 22 Sir, slide 12, please. Now the powerhouse. If we
 23 were to excavate the area around the powerhouse, you
 24 would find something very much like this. In maroon,
 25 this one, we can see the powerhouse itself. The

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1 slightly larger triangle, this one, is power station
 2 house. It is housing the generators, so we call it
 3 "generator hall" as well; whereas the slightly smaller
 4 one is the transformer hall, where the step-up
 5 substations are located to ready the current for
 6 transmissions. You will see it later on as well.
 7 More than that, there's a system of penstocks. You
 8 know that penstock, these are the pipes which take water
 9 for the turbines to rotate inside the generator hall,
 10 and then dispose it further into the Jhelum River, as
 11 I told earlier.
 12 Sir, there are different tunnels as well over here.
 13 You can see there's a headrace tunnel which brings water
 14 from the dam and then feeds to the penstocks. And then
 15 ultimately that is the discharge tunnel, which is our
 16 other tailrace tunnel, and many other light tunnels as
 17 well, which we'll come to later on in detail.
 18 And finally, looming above it, this one. It's the
 19 surge shaft. It starts from the headrace and goes above
 20 site, sir. It is to cater for emergencies, to allow
 21 pressure to escape from the headrace in the event of any
 22 emergency. Similar to surge shaft, we have a surge
 23 tunnel as well on the downstream side, to cater for
 24 similar emergencies.
 25 Slide 13, please. It's again the powerhouse record

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1 (indistinct). We have shown powerhouse here in detail.
 2 Other presenters will take you back to this again and
 3 again, so I will just give an overview of this slide,
 4 sir.
 5 As you can see, we have two main halls. One is
 6 a larger one, the other is a smaller one. The larger
 7 hall is a generator hall, whereas the smaller one is the
 8 transformer hall, which I showed earlier in red colour,
 9 sir. Then beneath the generator hall we have
 10 a structure of turbines, which stretches over the four
 11 floors.
 12 We can see third generator unit over here. Then
 13 there's a connecting shaft to the turbine over here.
 14 The turbine is shown, sir, in yellow, whereas the
 15 distinctive scroll case, that is shown in red. It's the
 16 point where the water enters into the turbines to run
 17 this. Then this water is disposed to a draft tube over
 18 here.
 19 Slide 14. The only thing which is above the ground,
 20 that is the NJHEP switchyard, which you can see over
 21 here, sir. And it will be shown to you during your site
 22 visit as well.
 23 Slide 15. This is the NJHEP tailrace discharge
 24 tunnel. It comes over here and discharges into the
 25 Jhelum River, which comes this way. I think you might

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1 have seen it while coming on the way to Muzaffarabad,
 2 sir.
 3 THE CHAIRMAN: Yes.
 4 MR JOYA: Slide 16, please. So this is the NJHEP hydraulic
 5 profile. When we pull out all this together, you get
 6 this, which is what is called the NJHEP hydraulic
 7 profile. Its purpose is to show the broad strokes, the
 8 main features of the NJHEP relative to the watercourses.
 9 We start on the right side. The Neelum River, it
 10 flows into the reservoir; and from here, it runs ahead
 11 unless it joins Jhelum River again. But simultaneously,
 12 as I told earlier, the headrace tunnel comes out of the
 13 dam site, then it splits into two, moves as a twin
 14 tunnel. And before entering the powerhouse, it
 15 reunites, it again becomes single. And after its
 16 function of turbines rotating, through the tailrace
 17 tunnel it gets discharged into the Jhelum River over
 18 here, downstream of Muzaffarabad, as I told earlier.
 19 Slide 17. Thank you. That's about the NJHEP
 20 tunnelling. We have just shown the hydraulic profile
 21 from the side, with the tunnel network you can see over
 22 here. There's the tunnel network, starts over here, and
 23 almost crossing under the Jhelum River. It reaches the
 24 powerhouse after traversing 30 kilometres, about,
 25 underground. And then from powerhouse, traversing

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1 4.4 kilometres more tailrace, it discharges into the
 2 Jhelum River.
 3 Next, please (slide 18). So thank you very much for
 4 your kind attention. You will see all these elements
 5 close up over the coming days, and these elements will
 6 be discussed separately as well by the experts. The
 7 purpose of this brief presentation was simply to
 8 orientate you what is to come. So if you have
 9 questions, I am over here, sir, at your disposal.
 10 THE CHAIRMAN: I have one question. It's probably of no
 11 great significance, but I'm curious about the exact
 12 location of the power station. So if we go back to
 13 slide 17 for just a minute, it looks like the powerhouse
 14 is relatively close to the tailrace area. And yet if we
 15 go to slide -- I think it's 11, it looks as though the
 16 powerhouse is rather far from the tailrace. So if you
 17 could just clarify that.
 18 MR JOYA: It's only -- you can see it's a satellite image.
 19 We have blown it up just to show the tailrace area more
 20 clearly. On the same scale, if I show the headrace as
 21 well, then well you can compare both areas.
 22 THE CHAIRMAN: So I think my confusion was: it almost looks
 23 like that's the upper part of the Jhelum River. But
 24 that's not the case: that's just a divide in the
 25 topography, yes.

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1 MR JOYA: It's just to show the tailrace more clearly.
 2 Otherwise length is the same, 3.4 kilometres, as
 3 I showed earlier, sir.
 4 THE CHAIRMAN: I understand. Thank you very much.
 5 MR JOYA: You're welcome, sir.
 6 THE CHAIRMAN: Questions? I don't think we have any other
 7 questions.
 8 MR JOYA: Thank you, sir.
 9 And now I hand over to Mr Usman-e-Ghani, Additional
 10 Commissioner for Indus Waters, who will take you through
 11 the schedule of the site visit, sir. Thank you.
 12 THE CHAIRMAN: Thank you very much, Mr Joya.
 13 MR USMAN-E-GHANI: Thanks very much, Joya Saab, Chairman
 14 Murphy, members of the court. You will all be very
 15 familiar with the schedule, as it was finalised upon
 16 your directions. So I would like to run simply through
 17 briefly, in case you have any questions, so they can
 18 accordingly be taken.
 19 In particular, I must note some changes to the
 20 schedule which I understand the court is considering.
 21 In particular, Day 3 of the site visit -- it is
 22 tomorrow -- has now been split into two, so that it will
 23 occupy all of the activities of Day 3 and Day 4. This
 24 means the events of Day 4 will now be shifted to Day 5.
 25 The events of Day 5 will be shifted to Day 6, and so on

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1 and forth. The order of presentations will remain the
 2 same.
 3 Once I have described the schedule, I will hand back
 4 to Mr Joya for the final limb of this introductory
 5 presentation, being the introduction of the speakers.
 6 I should add, the schedule is subject to change, maybe
 7 because of some weather conditions. Thank you very
 8 much.
 9 Our next slide, please (19). Day 1 was yesterday,
 10 and so we are at the start of Day 2. It is a shorter
 11 day, with two presentations only. The first one is this
 12 one which is being currently made.
 13 It will be followed by presentation no. 2, which
 14 will start diving a little deeper into the higher level
 15 features of the run-of-river hydroelectric plants,
 16 specifically on Himalayan rivers. Design, construction
 17 and operation issues will be examined in brief.
 18 After that, the court will be able to identify any
 19 specific questions or issues that it wishes to see
 20 addressed on the following days.
 21 Next slide, please (20). As you can see from the
 22 slide, Day 3 was intended to be a long day at the dam
 23 site. The schedule for this day has been modified
 24 a bit. We will depart early from Muzaffarabad, at
 25 8.00 am in the morning, aiming to arrive at the dam

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1 site, some 44 kilometres upstream, at around 9.30 am in
 2 the morning.
 3 We will then have four presentations over the course
 4 of the morning and afternoon, which are the site
 5 orientation, the presentation no. 3, to enable you to
 6 see the physical layout of the dam site before we go on
 7 to the conference room for the detailed presentations.
 8 Presentation no. 4 will provide an overview of the
 9 physical elements of the site, including geography,
 10 topography, geology and hydrology.
 11 After lunch, we will have two presentations on the
 12 basic elements of the headwork of the run-of-river
 13 hydroelectric plants. In terms of broad themes, the
 14 presentation no. 5 will address the sewerage and the
 15 flood control issues, and presentation no. 6 will
 16 address sediment management issues.
 17 As the subject matter of these two presentations
 18 also overlaps with the five questions that the court put
 19 to the site experts a few days ago, the site experts in
 20 these presentations will also address the court's
 21 questions.
 22 After these presentations, we will have
 23 an inspection of the dam and the reservoir of the site
 24 by the court. This presentation no. 7 on the schedule
 25 has now been moved to next day, on Day 4.

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1 On Day 3, the objective is to depart from
 2 Muzaffarabad after the presentation at around 5.00 pm,
 3 returning in time for closing the day, and for the
 4 dinner and other activities like that.
 5 Next slide, please (21). With Day 4 now being
 6 occupied with presentation no. 7, the dam and reservoir
 7 inspection, the presentation[s] of Day 4 [have] been
 8 moved to Day 5.
 9 It is another long day, taking place entirely at the
 10 powerhouse. We will depart from Muzaffarabad at 9.15,
 11 travelling downstream this time, arriving at the
 12 powerhouse at around 10.15.
 13 There will be four presentations over the course of
 14 the afternoon: presentation no. 8, which is general site
 15 orientation; presentation no. 9, which is basics of
 16 powerhouse; presentation no. 10, which is on power
 17 production; and presentation no. 11, which is the
 18 inspection of the powerhouse itself. The court will
 19 then have the opportunity to deliberate on-site before
 20 issuing the instructions for Day 5.
 21 The object is to depart from Muzaffarabad at around
 22 5.00 pm, arriving back again in time back to the hotel.
 23 Next slide, please (22). The events of Day 5 have
 24 been moved to Day 6, as I said earlier, which was
 25 originally the first contingency day. The Day 6 agenda

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1 is to be sent by the court. Once you have given us your
 2 directions, we will work with you to provide a schedule
 3 for this day.
 4 Next slide, please (23). The events of Day 6 have
 5 been moved to Day 7. It is currently listed as
 6 a contingency day in case of some inclement weather
 7 conditions or other interruption preventing some proper
 8 site instruction from taking place. If it is not
 9 required, then we anticipate departing from Muzaffarabad
 10 for Islamabad at around 1.00 pm, to arrive back to
 11 Islamabad by around 5.00 pm. An administrative meeting
 12 will be held thereafter to discuss the departure from
 13 Islamabad.
 14 Next slide, please (24). The events of Day 7 have
 15 been moved to Day 8, so we do not need to stay on this
 16 slide.
 17 Next, please (25). On Day 8, the court will depart
 18 from Muzaffarabad.
 19 And unless some clarification is needed, I may hand
 20 the floor back to Mr Joya.
 21 THE CHAIRMAN: Thank you very much, Mr Usman-e-Ghani. The
 22 only question I have -- it's not a question, it's just
 23 a confirmation that the idea of splitting the dam site
 24 into two days is very agreeable. We view it as very
 25 important to focus in particular on that site, and the

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1 decision that the timing would be optimised by having
 2 the two days is certainly agreeable to the court. And
 3 we're also aware that weather conditions may affect
 4 sequencing here, and we certainly are amenable to that
 5 as well.
 6 Any questions from anyone about the itinerary? No
 7 questions then beyond that. Thank you so much.
 8 MR JOYA: Thank you very much, Mr Ghani, for giving me
 9 a chance to speak again.
 10 Slide 27, sir. It's about the presenters to come
 11 here. Members of the court, Pakistan has assembled
 12 a range of hydropower experts from many different
 13 organisations within Pakistan. Many of them work at
 14 NJHEP and other hydropower facilities, both operational
 15 and under construction, throughout Pakistan. So they
 16 are now under the umbrella of WAPDA and in this house
 17 here as well, the experts.
 18 We also have two representatives with us from
 19 NESPAK. NESPAK is National Engineering Services of
 20 Pakistan, a government enterprise, an energy contractor
 21 which provides consulting, construction, engineering and
 22 management services globally. Its headquarters is at
 23 Lahore. It's one of the largest engineering consultant
 24 management companies in Africa and Asia as well. They
 25 are with us in this room.

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1 As I point out on the slide, I would ask them to
 2 raise their hands so as we can identify them. Thank
 3 you.
 4 So in front of you, sir, are the group of presenters
 5 number 1. Mr Ghani, the chairman of WAPDA,
 6 Mr Ghani Saab, he couldn't join us, as I told earlier.
 7 At the top, it's me, sir. Thank you very much for
 8 listening a lot. I had been general manager at Tarbela
 9 Dam as well, and project director at T5 extension in
 10 Tarbela as well. Now I'm general manager, coordination
 11 and monitoring in WAPDA.
 12 And Mr Usman-e-Ghani, please raise your hand, sir.
 13 He is from Additional Commissioners with us, thank you
 14 very much.
 15 Slide 29. This is our next group of presenters:
 16 Dr Tahir Hayat, Mr Ayub Malik and Mr Arfan Miana.
 17 At the top, we have Dr Tahir Hayat. Sir, please.
 18 Dr Hayat is one of Pakistan's most experienced
 19 megaproject engineer and administrator. He holds
 20 a bachelor's degree, master's degree in engineering, as
 21 well as doctorate. He is currently the chief executive
 22 of the consulting consortium, building the Diamer Basha
 23 Dam on the Indus. When completed, it will be the
 24 tallest roller-compacted concrete dam in the world,
 25 almost 272 metres high.

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1 We have another two members from NJHEP team:
 2 Mr Arfan Miana and Ayub [Malik]. Mr Miana, sir, please.
 3 Mr Miana has bachelor's and master's degree in
 4 mechanical engineering, and has worked with WAPDA since
 5 1992. He was involved in commission of 1,410 MW Tarbela
 6 4th Extension. He has been project director over there,
 7 and currently he is chief executive officer here at and
 8 NJHEP.
 9 And Mr Malik, he has bachelor's degree in civil
 10 engineering and a master's degree in irrigation
 11 engineering. He has 34 years of experience in
 12 construction management and contract administration,
 13 particularly in relation to the megaprojects. He is
 14 presently deputy project manager of NJHEP.
 15 Slide 29, please. So that's our next group of
 16 presenters: Mr Fiaz Hanif, Mr Umar Farooq and Mr Nayyar
 17 Alauddin.
 18 At the top is Mr Fiaz Hanif Sendhu, over here. He
 19 is our geology expert. He holds bachelor's degree and
 20 master's degree in geology and geohydrology, as well as
 21 a further master's degree in hydrology. He has 35 years
 22 of experience in the field of hydropower, and presently
 23 he is chief geologist of 1,530 MW Tarbela 5th Extension
 24 project.
 25 Then we have Mr Umar Farooq, who is the senior

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1 engineer in the Water & Agric division of NESPAK. He
 2 holds a bachelor's degree in civil engineering and
 3 master's degree in hydraulic and irrigation engineering.
 4 He is in the process of completing his doctorate on
 5 water source engineering.
 6 Mr Nayyar Alauddin. So Mr Alauddin has a bachelor's
 7 degree in civil engineering, and was employed by WAPDA
 8 in 1983 to 2019, finishing as a project director and
 9 general manager of NJHEP, the same project. He was
 10 thereafter hired as an advisor on NJHEP in 2019, and
 11 remains as a key part of the team today.
 12 Slide 30, please. And then we have our final group
 13 of presenters: Mr Tariq, Mr Arshad Malik, Mr Hameedullah
 14 Khan and Mr Yasir Abbas.
 15 Mr Tariq, he is over here. Mr Tariq holds
 16 bachelor's and master's degrees in engineering, and has
 17 over 30 years of hands-on experience with WAPDA in the
 18 field of hydropower operation and maintenance. He is
 19 currently one of the chief engineers of Tarbela 4th
 20 Extension.
 21 And then Dr Yasir Abbas. He is the chief engineer
 22 in the Water and Agric Division of NESPAK, and has been
 23 a practising water source engineer for 20 years. He
 24 holds a bachelor's degree in civil engineering, master's
 25 degree in hydraulics and irrigation engineering, and

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1 a doctorate in civil engineering.
 2 Mr Hameedullah Khan, he has a bachelor's degree in
 3 electrical engineering, and currently he is serving as
 4 chief engineer at Warsak HEP, which is undergoing
 5 intensive rehabilitation these days.
 6 Mr Arshad Malik. He holds bachelor's and master's
 7 degrees in electrical engineering. He has deep
 8 experience in thermal and hydropower throughout
 9 Pakistan, including as an additional chief engineer at
 10 the NJHEP as well. He is currently a chief engineer at
 11 WAPDA's hydropower projects.
 12 So that concludes this introductory presentation on
 13 behalf of Chairman Ghani, WAPDA, and the staff of NJHEP.
 14 Thank you, sir, for your kind attention, and we wish you
 15 a very successful site visit. If you again have some
 16 questions, we are at your disposal on this.
 17 THE CHAIRMAN: I don't think we have questions, but I do
 18 want to thank you for those introductions. They were
 19 very helpful, and I feel like there's a lot of degrees
 20 in this room! It's very impressive, and we're very
 21 grateful for all the time that you've taken to help put
 22 together this very distinguished cast of experts. So
 23 thank you, Mr Joya, and thank you to everyone.
 24 MR JOYA: Sir, thank you. With this, we are proceeding
 25 towards a break for coffee, if you like, sir.

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1 THE CHAIRMAN: Absolutely.
 2 MR JOYA: And then we'll come back after ten minutes for
 3 presentation no. 2 in the same [room].
 4 THE CHAIRMAN: Yes, that's fine. Why don't we resume in
 5 about 15 minutes, quarter past the hour. Thank you very
 6 much.
 7 MR JOYA: Thank you, Mr Chairman.
 8 (A short break)
 9 THE CHAIRMAN: Okay, I think we are reassembled, so why
 10 don't we proceed now with presentation no. 2.
 11 Presentation 2: HEP Design, Construction and Operation
 12 DR HAYAT: Thank you, sir. Mr Chairman, members of the
 13 court of arbitration, good afternoon.
 14 By way of introduction, although the introduction
 15 has already been made by Mr Joya, my name is Dr Tahir
 16 Mahmood Hayat. I'm presently working as chief executive
 17 of Diamer Basha Dam Consultants Group, which is a joint
 18 venture of six firms, like Stantec, AFRY and others.
 19 And we are providing consultancy services for
 20 construction of Diamer Basha Dam Project, which is
 21 a 272 metres high roller-compacted concrete, and
 22 4,500 MW hydroelectric plant. And it is in the [Khyber
 23 Pakhtunkhwa] Gilgit-Baltistan area of Pakistan.
 24 Alongside me is Mr Muhammad Ayub Malik, and he's the
 25 deputy project manager for Neelum-Jhelum hydropower

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1 project, and he'll be making part of the presentation,
 2 the latter half.
 3 So we have been asked to make the first substantive
 4 presentation of the site visit on hydroelectric
 5 projects, "HEP" for an acronym. And you will hear a lot
 6 of this "HEP", "HEP", and this is basically
 7 hydroelectric project: design, construction and
 8 operation.
 9 This presentation is intended as an introduction to
 10 the design and development process behind the
 11 run-of-the-river hydroelectric project on a Himalayan
 12 river, and the presentation will be basically in four
 13 parts.
 14 So in the first part, I will provide you with
 15 an overview of the HEP development process, setting out
 16 the various challenges that its designer and others
 17 associated with it will face, and eventually and
 18 hopefully overcome as part of that process.
 19 Secondly, I will address the question of HEP
 20 development, explaining how we start from a blank sheet
 21 of paper and actually design through various stages and
 22 phases to a design which can be put into practice by the
 23 contractor, and thus have a fully functional hydropower
 24 project.
 25 Thirdly, Mr Malik will explain the HEP itself,

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1 taking you through its major components and explaining
 2 how these fit together. And again, in the last part,
 3 Mr Malik will give you an overview of the HEP
 4 construction process: what challenges are faced in that
 5 process and at that stage. And basically, he'll be
 6 talking through the lens of the Neelum-Jhelum hydropower
 7 project, in which he has been associated for the last
 8 15 years.
 9 Your questions have been gratefully received, and
 10 will be answered later in presentations 5 and 6. If
 11 anything that I say or Malik Saab says you find it's not
 12 clear, and problems occur in your minds, you should feel
 13 free to ask questions at your convenience, please, and
 14 we'll be glad to answer.
 15 Slide 2, please. Before I go into the substance of
 16 the presentation, I would like to make a brief opening
 17 observation. The HEP design and development process may
 18 be described in three words: it is lengthy, it is
 19 expensive and it is challenging. It's lengthy,
 20 expensive and challenging.
 21 When we speak of a hydropower plant above a certain
 22 capacity, we are actually talking in terms of
 23 a megaproject. And these large-scale complex ventures,
 24 costing upwards of \$1 billion, take many years to
 25 develop and build. To be designed, constructed and

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<p>1 operated successfully, any megaproject must overcome 2 numerous hurdles across multiple dimensions. And when 3 you are talking about the Himalayan region, all these 4 hurdles are magnified. 5 With that, sir, slide number 3, please. We'll talk 6 now about the HEP development process. 7 And slide 4. So at the centre of this diagram, you 8 see the HEP design, which actually is HEP development, 9 let's call it. And it entails basically six main 10 components of design. 11 The first one is the technical studies and 12 engineering. And as we move clockwise, it's: contractor 13 selection and contracting; social impact assessment, 14 resettlement and compensation; environmental impact 15 assessment, mitigation and management; regulatory 16 activities, power planning and power sales; and, of 17 course, financial planning and financing. 18 Now, these six processes, they must run in parallel, 19 and they start almost from the conception stage, to 20 a certain degree. And then they are refined and more 21 detailed as the process goes along. And these must be 22 carried [out] in parallel. And failure of any one of 23 these could mean the failure of the project, or its 24 prolongation, or it's been put in "cold storage", as you 25 may call it. So all these are important. And I will</p> <p style="text-align: center;">Page 37</p>	<p>1 preparation, tendering process and bid evaluation, and 2 negotiation and award. 3 So these processes may take many months and involve 4 experts like advisors, lawyers, in-house and external, 5 to go through all these processes. So the early steps 6 are typically carried out in parallel of the feasibility 7 studies or pre-feasibility studies. And then, later on, 8 during the next phases, these are refined. And during 9 this process, the assistance is also taken from 10 internationally recognised construction precedents, such 11 as those produced by FIDIC, which is the International 12 Federation of Consulting Engineers. 13 Now, FIDIC produces typical templates of multiple 14 contracts. But the most important of these for the 15 purpose of the HEPs are the Red Book, which is 16 applicable to large construction projects generally; the 17 Yellow Book, which deals with electrical and mechanical 18 works; and the Silver Book, which deals with what I just 19 said: EPC, or engineering procurement and construction, 20 which is basically a turnkey project. So these are the 21 internationally recognised templates which, with some 22 modification, people normally use to make these tenders. 23 Slide 7, please. Next we have the social impact of 24 the project. So no project is without social impacts. 25 These social impacts are usually measured using a range</p> <p style="text-align: center;">Page 39</p>
<p>1 take you through each of these later in the 2 presentation. 3 Let's look at slide 5, please. So here we have the 4 design phases of hydroelectric power project, HEP. They 5 go from concept, to pre-feasibility, to feasibility, 6 engineering design, and construction design. And one by 7 one, I'll explain. 8 So in each phase there is a yes-or-no answer to 9 proceed to the next phase. From the concept, yes, it is 10 good: you go to pre-feasibility. Okay, go ahead. Then 11 feasibility, and then of course all the others. So at 12 each phase there is an answer whether to proceed with 13 the next level or not. 14 Slide 6, please. Next we return to our contractor 15 selection, which obviously is a critical phase in any 16 project. So the life-cycle is shown on the left. 17 So actually the project gets built by the 18 contractor. It is designed by the engineers, but it 19 gets built by the contractor, unless and until it is 20 an EPC contract. So for normal projects, the idea is 21 that the engineers design, the consultants design, and 22 the contractors who win the tender build this project. 23 So from the initial stages of the project, you have 24 to have a project procurement strategy, contract 25 strategy and packaging, tender preparation, contract</p> <p style="text-align: center;">Page 38</p>	<p>1 of internationally recognised standards, such as the 2 Equator Principles or the standard guidelines which are 3 produced by institutions such as the International 4 Finance Corporation or World Bank or the Asian 5 Development Bank. 6 So HEPs are actually very intrusive into the fabric 7 of geography and communities in which they are located. 8 However, due to the typical small size of the 9 run-of-the-river reservoir, they are typically less 10 impactful than the storage projects, which have much 11 larger reservoirs. 12 So the HEP construction can significantly impact the 13 community in or adjacent to the construction area. We 14 have some examples on the slide which I'll show you. So 15 there could be involuntary displacement of communities, 16 we can have water quality reduction and increase in 17 waterborne diseases, loss of agricultural land, loss of 18 commercial opportunities -- fishing, mining, tourism -- 19 loss of spiritual or other indigenous site, to name 20 a few. 21 And there are mitigation strategies and mitigation 22 processes available. For example, appropriate site 23 selection. If a dam site is near to a community, we 24 will try to look for an option where it is far from 25 a community so that we don't have that much of impact.</p> <p style="text-align: center;">Page 40</p>

1 Restoration of resettlement and livelihood. So we
 2 make better villages, give them better facilities; so
 3 whatever they had before, they will have a much better
 4 life in that area. And payment of compensation, of
 5 course, for their movement and all of the things. But
 6 if no mitigation is possible, however, then the site
 7 would be basically unsuitable.

8 And by the way, if the social impacts of the
 9 projects are not managed, the project will fail at the
 10 very least, and become more challenging to implement,
 11 including because the investors and lenders will be shy
 12 to support such a project. So if the project backers
 13 insist on pushing on the project regardless of the
 14 legitimate objections of the locals, then they will find
 15 it very hard to get international or private funding.

16 Slide 8, please. So the environmental impacts are
 17 also similar in nature, somewhat. And this details some
 18 of them, like impact on wildlife, which is flooding of
 19 natural habitats, possibly including some endangered
 20 species; effects on fish and other aquatic life,
 21 floating aquatic vegetation, loss of terrestrial
 22 wildlife.

23 Wider impacts could be downstream hydrological
 24 changes due to stream flow, sediment transport, water
 25 quality, because there will be reduced flow downstream,

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1 reservoir sedimentation, greenhouse production from
 2 reservoirs, and waterborne diseases.

3 There are again potential mitigation strategies
 4 available. For example, we select an appropriate site
 5 so that it does not impinge on any natural habitat.

6 There are environmental offsets. For example, if
 7 you have greenhouse gases production from the reservoir,
 8 it is normally because there's a lot of jungle in the
 9 reservoir that will be submerged, and it will decay and
 10 produce the gases. So one strategy would be to go ahead
 11 and cut the jungle in that area before you inundate that
 12 area, and then replant the trees all around the
 13 reservoir so that you have a positive effect of that.
 14 Because at that time, you have a reservoir, you have
 15 more ambient moisture in the air, so that will support
 16 vegetation in the area.

17 So all these techniques are used to overcome these
 18 environmental impacts. Again, if no mitigation is
 19 possible, the site may be rendered unfeasible.

20 Slide 9, please. So the next challenge is
 21 financing. You have to build a project, you need money
 22 for that.

23 The total cost of a major Himalayan HEP can run into
 24 billions of US dollars. For this reason, lack of
 25 financing is one of the most common reasons for

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1 a project failure or its being put into cold storage.
 2 The project is okay, everything is fine, all the
 3 indicators are good, yet you don't have the money to
 4 build it. Then it will be put into cold storage.

5 So as the slide shows, it starts with financial
 6 analysis and tariff analysis, which is basically how
 7 much it's going to cost to build, obtain all the
 8 permits, all the resettlements, all the costs,
 9 everything included; and what are the tariffs and what
 10 are the returns that you're going to get. So is that
 11 positive? Is the EIRR, FIRR, all the economists, they
 12 do all those things, and cost-benefit ratio. So if that
 13 is positive then the project is positive.

14 THE CHAIRMAN: Dr Hayat, can I just ask you a question?
 15 When you say "tariff analysis", we're speaking about the
 16 tariffs in essentially selling the power from the plant?

17 DR HAYAT: Selling the power to a utility or to the
 18 government, sir.

19 THE CHAIRMAN: Thank you.

20 DR HAYAT: Yes, sir.

21 So then there are options that are available to the
 22 builders, whether they go for debt funding options or
 23 they go for equity funding, or there could be a mixed
 24 bag. And then they have to go for financing agreements
 25 with various agencies to secure all the funds that are

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1 required before they actually embark on the
 2 construction. And these are all -- so final stage is of
 3 course negotiations, signatures of financial agreements,
 4 and all that.

5 Slide 10, please. So the financing track is
 6 actually usually tied to the next significant challenge,
 7 and that is the regulatory activity. By this, I mean
 8 the process in which the project acquires the various
 9 agreements and permits that it will need for the HEP to
 10 operate in due course. So the project financing will
 11 only be available, or contingent, if you have all the
 12 permits in place. And these must either be obtained in
 13 advance or in accordance with precisely defined
 14 timelines set out in the financing agreements.

15 So on this slide, we have illustrated a selection of
 16 kind of regulatory instruments that the project must
 17 have in place. And most probably, the most complicated
 18 of these is the power purchase agreements, as you
 19 pointed out, Mr Chairman.

20 This is a long-term contract between the electricity
 21 generator and the customer, usually a utility or
 22 a government or a company. The PPA, or the power
 23 purchase agreement, can last anywhere between 5 and
 24 20 years, and it's a good measure of the financial
 25 viability of the HEP.

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1 So PPA can either be for a predefined amount of
 2 energy or a predefined percentage of energy that the HEP
 3 will eventually generate.
 4 Beyond PPA, there are of course other instruments
 5 that the project will need to obtain. So there are land
 6 acquisition agreements. The land that is inundated, or
 7 the land that is required for building the dam or the
 8 reservoir area which is inundated, it could be
 9 government land: then you will need government
 10 permission. If it is private land, you'll have to talk
 11 to the private owners and give them compensation. So
 12 all those agreements have to be in place.
 13 And water right agreements, because you will be
 14 using water of the river. So agencies will be
 15 responsible for the water of the river, and you'll have
 16 to go to those agencies to get the permit that, "I want
 17 to use this water for building the dam", because there
 18 will be some storage for some time. The effect is not
 19 that much for a run-of-the-river project, but it is more
 20 for a storage dam. But in any case, you need water
 21 rights agreements.
 22 And you need project implementation and concession
 23 agreements, and mostly the government agencies are
 24 responsible for this. And any other necessary permits.
 25 So with this review, you'll be able to see the

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1 a cascade of facilities, or was it seen more as
 2 a standalone facility?
 3 DR HAYAT: At this point in time, it is a standalone. But
 4 there are possibilities of sites downstream which could
 5 make into a cascade. But, you see, if you see all the
 6 projects -- because Neelum or Kishenganga is only part
 7 of the river: it joins Jhelum. So in that sense, it is
 8 part of Jhelum also. And on Jhelum, you have Kohala,
 9 you have many other projects before you hit Mangla: you
 10 have Mahl, you have Karot, and all those other projects.
 11 So it can be considered as a part of a cascade also in
 12 that sense.
 13 DR BLACKMORE: Thank you.
 14 MR MINEAR: Excuse me, Mr Hayat, now that we've interrupted
 15 you, can I ask: are water rights in Pakistan
 16 administered at the national, regional or local level?
 17 DR HAYAT: To my understanding -- I think I will refer this
 18 to one of my colleagues here, and I will come back to
 19 you later on that. But very briefly, I think both the
 20 provinces and the central government gets involved in
 21 this. But we will clarify that more in detail as we go
 22 along.
 23 MR MINEAR: Thank you.
 24 THE CHAIRMAN: I have a question that relates to contractors
 25 that you discussed. And again, if you're not in

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1 reality. I mean, going through all of this is not easy,
 2 to say the least. This is some exercise that you have
 3 to carry out. I see some smiles on some faces here!
 4 And as I said earlier, it is lengthy, it is expensive
 5 and it is challenging. And with that said, it is not
 6 for the faint of heart, you know? So the projects that
 7 do succeed and see the light of day often stand as
 8 a testament to the designers' and backers' creativity
 9 and tenacity.
 10 Can we move to slide 11, please. So we have looked
 11 at the challenges in development.
 12 DR BLACKMORE: I was interested in that list. I'm just
 13 wondering: when you have a sequence of hydropower
 14 facilities on the one river, and you need each of those
 15 things for an individual site -- so I understood all of
 16 that -- does the government have a -- who owns the grand
 17 plan for how the river will be developed? So we
 18 generally don't just put one hydroelectric plant in: you
 19 have one --
 20 DR HAYAT: Cascade.
 21 DR BLACKMORE: And you have a cascade, and so on. And I was
 22 looking up there to see whether -- it's embedded in
 23 water rights, and all sorts of things. But I was just
 24 wondering whether, for something like this dam, the one
 25 we're talking about now, was that seen as part of

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1 a position to answer, that's fine. But I'm just curious
 2 whether, as a general proposition, there's a limited
 3 number of contractors -- global contractors -- that do
 4 this kind of work, or whether it's a very fragmented
 5 population that you can sort of pick and choose from?
 6 DR HAYAT: Normally, when a large hydropower project comes
 7 into being and it is designed, it is then put up and the
 8 tenders are ready, it is put up for international
 9 bidding. For such hydropower projects, it is not
 10 uncommon that there is not one entity and not one
 11 company that can undertake single-handedly such large
 12 projects. Yes, the bag is maybe limited. I mean,
 13 there'll be maybe a dozen companies or two dozen
 14 companies that do hydropower, and there'll be a dozen
 15 companies -- or less than that even -- who do the
 16 hydromechanical and the electrical part of that, and
 17 I can maybe count them on my fingers.
 18 But what happens is that they form joint ventures,
 19 because it's such a -- you know, Diamer Basha Dam, where
 20 I'm working, its expected cost is to touch \$16 billion.
 21 Now, this type of a project requires -- there's no
 22 company, or construction company even, that can
 23 single-handedly handle all this thing. So normally they
 24 come in a group of two or three.
 25 And what normally happens is you have a civil side

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1 of the contract which the civil contractor takes up, and
 2 then you have the electrical, which maybe another person
 3 or another entity. And then the hydromechanical, like
 4 gates and other things, they go to another party, and
 5 they come and join hands. Or maybe sometimes even the
 6 designers or the client, let's say WAPDA, they also
 7 sometimes package them differently, so they are not let
 8 out as one single contract.

9 For example, in Diامر Basha, we are making six
 10 contracts, which is main works 1, main works 2,
 11 hydromechanical 1, hydromechanical 2,
 12 electrical-mechanical 1, electrical-mechanical 2; so six
 13 contracts. So it depends on various scenarios and how
 14 you want to proceed.

15 Does that answer your question?

16 THE CHAIRMAN: Thank you, yes, very helpful.

17 DR HAYAT: Thank you, sir.

18 So we have looked at the challenges in HEP
 19 development. Now, let's look at how the design process
 20 functions from concept to execution.

21 You will recall that we set out five stages of HEP
 22 design by way of introduction. Now I will examine them
 23 in slightly more detail. Obviously there are different
 24 methodologies, but this is the generic one that I will
 25 be explaining.

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1 process will determine whether it is worthwhile even
 2 considering the site for hydropower production. I mean,
 3 if you have stream gauging -- normally it is there in
 4 Pakistan and all the other countries also -- you have
 5 the data on river flows throughout the year, and
 6 normally spanning many decades: 60, 70, 80, sometimes
 7 more than 100 years. So you know how much water is
 8 coming in that stream, and whether it is viable to
 9 actually put hydropower in there. Is there firm water
 10 available throughout the year, or most part of it?

11 So at the concept stage, the power demand that the
 12 project will aim to meet will also need to be
 13 identified. And once the site is selected, a desk study
 14 to develop the concept is undertaken, which will involve
 15 selecting the basic design of the HEP, together with its
 16 proposed capacity.

17 So basic design and proposed capacity, and
 18 developing the basic operational procedures that will
 19 determine the concepts, energy generation and daily
 20 income in very broad -- it's like a broad brush, you
 21 know. It's the early stages. So that is the concept.

22 If the resulting concept is sufficiently positive,
 23 then the HEP designer will set down a budget for future
 24 development. It all boils down to money that you have
 25 to spend, you know, eventually. So you have to see: is

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1 Slide 12. Project conception. So this is basically
 2 a desk study, and this is where you conceive a project.
 3 And this is done, for instance, first time, by screening
 4 the national inventory.

5 By the way, this is a small -- you will see the full
 6 scale of this later on, but this is a glimpse of the
 7 Pakistan hydropower potential inventory, prepared by
 8 WAPDA. For example, here you see the ones in this
 9 bluish colour are those in operation; under
 10 construction; ready for implementation, for example.
 11 Like here, here, here. In operation, of course. Then
 12 detailed design of those which have been carried out;
 13 under study.

14 So this is the national inventory. So depending on
 15 where you need your power -- and you can find something
 16 in the national inventory which has gone to maybe
 17 a slightly advanced stage, or you know that this is
 18 a potential site which is a good site, then the first
 19 site is the project conception. So we screen this
 20 inventory, or the investors screen this inventory and
 21 see which one is the one that they would like to take
 22 ahead.

23 So using this basic information available at each
 24 site -- for example, available seasonal flow, because
 25 flow is necessary for power generation -- the screening

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1 it worthwhile going ahead on this one? At each step you
 2 ask that question as you go along the process.

3 But the most important decision that has to be made
 4 at this stage is whether a hydroelectric plant will be
 5 a storage dam or a run-of-the-river project. I wish to
 6 pause here, and I will point out the difference between
 7 the two, because you will be hearing a little bit about
 8 this over the next presentations also.

9 First, I'll talk about storage dams. As the name
 10 suggests, a storage dam incorporates a reservoir
 11 upstream to store water. So the question is: why do we
 12 store water? Answer is: because the flows in the river
 13 vary from season to season, and even from year to year.
 14 So there are months in the year when the river will
 15 receive a lot of rainfall, and abundant flows are
 16 available which are more than required. So these are
 17 called the "wet months". So in Pakistan, the wet months
 18 are typically from May to September. Monsoons come in,
 19 and we have catchment, and snowmelt is there.

20 On the other hand, we have the dry months, in which
 21 the flow is low. And normally in Pakistan it is from
 22 October to April.

23 So regardless of the flow variation, the demand of
 24 the water remains, and that is for electricity
 25 generation and also for irrigation, for a country like

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1 Pakistan, for example. You need water for irrigation.
 2 So you need that also in the dry months when only the
 3 river flow is not sufficient to meet all the demands.
 4 Therefore, at that point in time you use the water that
 5 you have stored in the reservoir during your wet months,
 6 and use it during the dry months for your irrigation
 7 needs and your power generation.
 8 Second are the run-of-the-river projects. These are
 9 only used for generation of electricity or power. In
 10 general, very broad terms, in a run-of-the-river
 11 project, the water coming into the river is equal to the
 12 water that goes out of the power station back into the
 13 river. So that is, in very broad terms,
 14 a run-of-the-river project, unless the water coming in
 15 the river is more than what is required at the power
 16 plant. In that case, as you see in the Neelum-Jhelum,
 17 we have spillways: you can spill over back into the
 18 river.
 19 However, since these plants are basically for power
 20 generation, and power generation is -- and power demand
 21 actually, power demand, I would say, is variable during
 22 the day. During the night, when people sleep, the power
 23 demand goes down. And during the day, when people
 24 start, and businesses start opening, factories start and
 25 everything, the power demand surges. So in a 24-hour

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1 day period, there are ups and downs in power demand.
 2 Therefore, a small reservoir is needed as
 3 an operational pool. So that during the lower demand
 4 period, you will store enough water in that small
 5 reservoir or pondage so that, during the high demand
 6 period, you will release that water that you have stored
 7 in that 24-hour period into the power station to
 8 generate more electricity.
 9 So the powerhouse will be working at different
 10 levels: it will generate more electricity when it is
 11 needed, and it will be generating less electricity when
 12 it is not needed. So this is the typical
 13 run-of-the-river situation, and this is called "peaking"
 14 also. When you peak the power during the peak demands,
 15 that is called the "peaking operation". So for
 16 a 24-hour period, you store that much water during the
 17 low demand, and use it during the high demand. So this
 18 cycle is repeated daily.
 19 So relating to the choice between a storage or
 20 a run-of-the-river project is the power production.
 21 Now, the power equation is simple. The power that you
 22 can produce from a power plant, in very simple terms,
 23 is: you multiply the head of water with the amount of
 24 water that flows through the turbines. And what is the
 25 head of water? It is the level of water in the

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1 reservoir that you create, and basically your tail water
 2 level. So higher the head, higher will be the energy
 3 that you will produce because it will give you that much
 4 higher pressure at that.
 5 And the other variable in that is the amount of
 6 water, the volume of water in cubic metres per second
 7 that you flow through the turbines. So higher the flow
 8 through the turbine, higher will be the energy that you
 9 will produce. If you have higher volume of water and
 10 higher head, it is very good, you will be able to
 11 produce very good electricity.
 12 So an engineer who is actually designing a project,
 13 or the financier or anybody that is backing the project,
 14 he would like to maximise the power potential of a site.
 15 That is natural because you want to get the maximum
 16 money out of your project, you want to get the best
 17 return on your project. Now, in a storage project, this
 18 is usually done by creating a tall dam or a very high
 19 dam. As I said, in Basha we are creating
 20 272 metres-high dam, with a very high storage.
 21 So that is the head that is available at the dam
 22 site. So that is used for storage, and you use that
 23 head with a high dam to produce electricity, because
 24 higher the head, you produce more electricity.
 25 In a run-of-the-river project, a massive reservoir

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1 is not needed. The necessary head can be created
 2 through a low dam with a small reservoir, and which is
 3 connected to the turbine via a tunnel, in a descending
 4 tunnel.
 5 So you use the topography, which in Himalayas is
 6 quite steep. So you have a small reservoir, and you
 7 divert the water in a tunnel, and the tunnel is then
 8 taken to a powerhouse which is, due to the topography,
 9 at a much lower elevation. So your reservoir, which is
 10 a small one, is at a high elevation; your powerhouse is
 11 at a lower elevation because of the distance. In
 12 a smaller distance, you get -- the topography changes
 13 a lot, there's a high head.
 14 Like in Neelum-Jhelum, with this 28.5 kilometres of
 15 tunnel, the height of the dam at Neelum-Jhelum is only
 16 47 metres, yet the head that we have created is
 17 420 metres. If you were to build a dam to create that
 18 head, a high dam, the dam would have been at least
 19 420 metres high at this place.
 20 So this is the difference between a storage dam and
 21 a run-of-the-river project. So you use the topography
 22 to your advantage.
 23 And this advantage -- yes, sir, please,
 24 Mr Blackmore.
 25 DR BLACKMORE: I'm just interested, given that we're talking

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1 about the philosophy here, and the planning for the
 2 country, and the elements that go into run-of-river and
 3 storage, so I was just thinking as you go through it --
 4 because it's a very powerful presentation, so thank you
 5 for that. I just haven't heard the word "climate
 6 change". Is climate change a key part of the thinking
 7 for some of these dams?
 8 DR HAYAT: Very good question, sir. Very good question,
 9 sir. Everybody is worried about --
 10 DR BLACKMORE: I have two more, but we'll do climate change
 11 first.
 12 DR HAYAT: Okay. I'm most glad to answer your question,
 13 sir. Most welcome, sir.
 14 Yes, it is on our mind, sir. Again I'll refer back
 15 to my own project, which is the Diamer Basha Dam
 16 Project. Indus is the most snowmelt-fed river in the
 17 world, sir. We have more than 18,000 glaciers in that
 18 area.
 19 When the project's feasibility was done, it was
 20 thought that the maximum flood that could be generated
 21 in that river will be by a GLOF event. "GLOF" stands
 22 for "glacial lake outburst flood", G-L-O-F. So as the
 23 glaciers melt -- that is their behaviour -- there are
 24 glacial lakes. And at any given point in time,
 25 a glacial lake may burst unexpectedly. And then you get

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1 all that flow and debris coming into the river.
 2 So we studied that at the feasibility stage that was
 3 done in 2002, 2003 and 2004. And at that time we
 4 thought that we would get a 49,500 cumecs flood because
 5 of the GLOF. But because of the large reservoir -- by
 6 the way, the reservoir here holds about 8 million
 7 acre-feet of water, and it's 100 kilometres long. So it
 8 has some absorption capacity.
 9 So the outflow in that flood was only about
 10 35,000 cumecs, the spillway capacity. So that was the
 11 probable maximum flood; and you'll hear more about that
 12 in presentations 5 and 6 as we go along.
 13 Later then, when we were doing this construction
 14 design, we were looking at what your question is,
 15 climate change. And we said: what has happened to the
 16 glaciers? What has changed in the snow cover? Is there
 17 anything that is required that we should change their
 18 design or we should have a re-look at that?
 19 So again we contacted the same professor -- and by
 20 the way, he is Professor Reynolds; maybe you are
 21 familiar with his name. We contacted
 22 Professor Reynolds, and we requested him that he carry
 23 out this study for us. And over a few months, he did
 24 that study, and he came up with a very surprising
 25 answer. And now we are talking about the difference

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1 only between the last 20-25 years. And he said that
 2 many of the glaciers have melted, the track from GLOF
 3 has reduced significantly. This is the climate effect,
 4 you know?
 5 And now, instead of the 49,500 cumecs, the GLOF
 6 event can only generate about 14-15,000 cumecs. So that
 7 was a sigh of relief also. But there were other factors
 8 that came in, and our flood was high; that is another
 9 reason.
 10 And the other reason for climate change is:
 11 previously the monsoons never went in the catchment area
 12 of Diamer Basha Dam. But in the last one decade we are
 13 seeing that monsoons are ingressing into the catchment
 14 of Diamer Basha Dam. And when we take that into
 15 account, the combination of snowmelt and the monsoon
 16 ingress actually creates the PMF, which in this case we
 17 calculated, with climate change added for the duration
 18 of the project, adding that 10% extra in that to take
 19 care of any future climate change also, it comes out to
 20 be 42,000 cumecs. But the previous GLOF was a duration
 21 of only like two days. This one is sustained over three
 22 weeks. So 42,000 over three weeks, and then we had to
 23 discharge, but the discharge capacity came out to be
 24 similar, like 35,000 cumecs, so we designed the spillway
 25 to that.

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1 So yes, climate change is real, it is here and we
 2 have to take care of that. And I will talk about later
 3 that it is thought that in the Indus Basin, in the
 4 Indus, we are going to see something like, people say,
 5 17% reduction in the volume of water that is going to
 6 flow in this river, because of climate change, annually.
 7 DR BLACKMORE: So my next question: I look at this as
 8 hydropower, right, hydropower potential in all of its
 9 forms. There are many forms, which you've discussed.
 10 But over here, I see countries such as Pakistan and
 11 others that are going down a journey of green power --
 12 wind, solar -- and using hydropower or hydropower
 13 storage as an offset for the times when the wind doesn't
 14 blow and the sun doesn't shine. So I'm just wondering:
 15 is the background to the way we're now thinking about
 16 this network here of opportunities, looking for what
 17 a green future might be -- you've got climate change,
 18 which you've just discussed, thanks. But I'm just
 19 wondering about whether solar now is by far the
 20 cheapest. Like in Australia, it's by far the cheapest
 21 unit of power you can get, but [there's] not too much
 22 solar at midnight. And we're looking to invest very
 23 heavily.
 24 THE CHAIRMAN: What's the question?
 25 DR BLACKMORE: The question is whether we're integrating,

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1 into the planning of the hydropower, solar and wind.
 2 DR HAYAT: Sir, we are. As you know, sir, already the
 3 energy mix in Pakistan is skewed. And that's why our
 4 energy bills are out of the roof, you know? Normally it
 5 should be 70/30: 70% hydro -- ideal mix -- and 30%
 6 other. Here, we have almost the other way round.
 7 The problem with hydro is also it's seasonal
 8 variation also. During high-flow season, you have
 9 enough water that you can release and generate
 10 electricity all the way round. And that is when we
 11 have, by the way, peak demand also, because those are
 12 the hot months in Pakistan, all the air-conditioning is
 13 going on and things like that.
 14 But during winter months, the power-plants normally
 15 go down to almost 30% or 25% of their capacity because
 16 of the low flows; and you're storing water also for your
 17 crops and things like that. So you have to have
 18 something additional coming in. That is one factor
 19 where our other thermal and nuclear power-plants come
 20 in.
 21 That being said, yes, we have -- the government has
 22 a very aggressive policy of pursuing other green
 23 alternatives. This is a green alternative also, because
 24 it doesn't emit any gases or things like that,
 25 hydropower. But in terms of wind and solar.

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1 You had a third question, sir?
 2 DR BLACKMORE: No, I'll stop, that's fine.
 3 PROFESSOR BUYTAERT: As a quick follow-up question on the
 4 discussion about energy storage, has Pakistan any plans
 5 for pumped hydropower?
 6 DR HAYAT: I think, to the best of my knowledge, there was
 7 some talk of pump storage. This is one of the good
 8 options that is available to any country that, during
 9 low demand, you actually use the electricity that you're
 10 producing to take water up, store again. So it's
 11 a cyclic sort of situation, pump storage: you pump the
 12 water back and use it for peaking.
 13 So to my knowledge, I think the sites may be
 14 an issue. But yes, that is an option that must be
 15 studied. But I'll come back to you with more
 16 information when I get that.
 17 PROFESSOR BUYTAERT: Thank you.
 18 THE CHAIRMAN: Thank you very much. Continue, please.
 19 DR HAYAT: Thank you, sir.
 20 So slide 13, please. Pre-feasibility study. So
 21 with the basic concept in hand, the next step is to
 22 undertake the pre-feasibility study. Now, the starting
 23 point is, for example, a site visit to get further
 24 data -- in particular, hydrology -- to ensure sound
 25 basis for the computation of future energy; more

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1 But that being said, somebody quoted me an example
 2 from Australia. We have to be very careful when we go
 3 on that path, you know? Because when you rely too much
 4 on your solar or your wind, as you said, it is not
 5 a very stable power system, and your system could become
 6 unbalanced. And now I'm told that the Australian
 7 Government is plugging in other like hydropowers and
 8 things like that to make their system stable.
 9 So yes, we are pursuing that, but with caution
 10 that -- yes, especially in rural areas, for example,
 11 where it is difficult to even take transmission lines
 12 and all that, solar and wind could be -- you take them
 13 off the national grid, you just keep them independent.
 14 Or even from larger plants.
 15 I mean, the technology is evolving day by day. The
 16 problem with solar and wind is their storage, because it
 17 is only -- not so much with wind, but with solar. So
 18 unless you have some good power storage capacity --
 19 which is, by the way, advancing day by day, [Tesla] and
 20 I don't want to name other companies. They are
 21 producing these power banks and power systems where you
 22 can store power.
 23 So as it grows, I'm sure there will be a time when
 24 these will become much more attractive, and I think that
 25 is the way to go.

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1 comprehensive data on basic layout of the hydropower,
 2 HEP; cost-benefit analysis.
 3 And this whole analysis is not actually absolutely
 4 confirming that the hydropower is going to work as
 5 a technical and economic prospect. Rather, the
 6 pre-feasibility study is intended to determine whether
 7 a full feasibility is needed or not, because full
 8 feasibility is quite a substantial undertaking.
 9 And again, it boils down to money. So the investor
 10 or the government entity wants to make sure in the
 11 pre-feasibility that it is worthwhile moving to the next
 12 stage, i.e. feasibility stage. So we take one step at
 13 a time. So in the pre-feasibility we see that, yes,
 14 there was a concept, we've gone through the
 15 pre-feasibility and all the boxes [are] checked, so we
 16 now can move to the feasibility level.
 17 So this is not confirming absolutely the viability
 18 of the project, but to say: yes, we move to the next
 19 stage, which is a full feasibility.
 20 Slide 14, please. So a full feasibility study is
 21 actually taken to determine, with a high degree of
 22 probability, that the project is technically,
 23 environmentally and financially viable. Three main
 24 boxes that have to [be ticked]: whether it is
 25 technically, economically and environmentally feasible.

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1 So this study actually focuses mainly on these three
 2 aspects and there are other things which run in
 3 parallel, as I said, but these are the three main
 4 things.
 5 And then of course you decide what further studies
 6 are required. So a full hydrological and geological
 7 analysis of the project site is done at this stage.
 8 Environmental studies are done to a greater extent.
 9 A lot of site investigations are done: drilling, taking
 10 samples, testing.
 11 And then, with all the data that is coming in, you
 12 basically develop alternatives, which dam site will be
 13 suitable. So it's not one type sometimes that suits
 14 every place. So you will say: should I go for a CFRD,
 15 ECRD, or should I go for a concrete dam? Is it gravity?
 16 Is it arch? All those things. Where will be the
 17 powerhouse? What will be the capacity?
 18 So you make five, six, seven alternatives. Then you
 19 design them with a broad sort of brush to an extent and
 20 then select, with all these things, which is the best
 21 alternative out of these that you can then take forward
 22 in your feasibility study. So first you do a broad sort
 23 of a sweep, and then you narrow down to your one or two
 24 preferred alternatives in this feasibility, and you then
 25 finally go with one.

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1 So this runs in parallel with the environmental,
 2 social, financial, regulatory, contracting activities
 3 which I have referred before. It serves three purposes:
 4 first, it allows for further optimisation of the concept
 5 which was developed at the feasibility stage, and each
 6 element is designed to a higher degree. And it serves
 7 as a basis in which the tender drawings are made.
 8 This is important, because these are the drawings
 9 based on which you will develop the bill of quantities,
 10 you will cost the project, and that will become a part
 11 of the tender, i.e. the drawings and the bill of
 12 quantities, and of course the other specifications and
 13 things like that, they will become part of the whole
 14 tender document which will be floated on the
 15 international market. The contractor will have that
 16 information. He will look at that and then he will bid
 17 for the project.
 18 So when this is done, this allows the implementer of
 19 this project that he can then proceed to the
 20 construction phase. So the engineering design is
 21 actually a bridge between the design and construction.
 22 And if you engage the contractor early, you can
 23 start early. And as a rule of thumb which we normally
 24 use: that 1,000 MW produces electricity which is valued
 25 at \$1 million per day. So this is just a basic rule of

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1 So the selected alternative will be designed, and
 2 its cost estimated reasonably. That will include the
 3 cost of equipment and construction, and the analysis of
 4 HEP operation strategies, a computation of expected
 5 energy production, analysis of tariff values/markets
 6 together with project finance alternatives; analysis of
 7 social/environmental impacts, together with appropriate
 8 mitigation strategies, which we talked about;
 9 development of comprehensive plan for project
 10 implementation.
 11 So again, at the end of all these studies -- and by
 12 the way, there is a whole gamut of experts of various
 13 fields that come together to do this, all across the
 14 board, and combine together. Then, as I said, we decide
 15 whether the project is technically, environmentally and
 16 financially feasible. And if it is, then we take the
 17 next step. And the next step is the engineering design.
 18 Slide 15, please. This, by the way, in here shows
 19 a drawing that is produced of many drawings, thousands
 20 of drawings. Actually, in a project like Neelum-Jhelum,
 21 even you have 15-20,000 drawings. Let that sink in:
 22 15-20,000 drawings.
 23 So this is a drawing looking from the top of the
 24 powerhouse. You can see the generator or the turbine
 25 setting and all that.

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1 thumb. And so this gives you an idea that if the
 2 project is late, how much you are losing. And if you
 3 start early, you are good at design, how much money
 4 actually you start making as early as possible. So
 5 people are very keen to start their project early.
 6 So at this point in time, only 20% of the expense
 7 has actually been made, or less than that. Actual money
 8 starts flowing out when you go into construction. So
 9 the 80/20 principle applies here also. So only 20% is
 10 what you have spent up till now. The big chunk is still
 11 ahead of you; that's the big challenge. So you have to
 12 be very sure that all that you have done is of due
 13 diligence, and it is workable, it is doable. And as
 14 I said, with all the other permits and all those other
 15 things coming in.
 16 So, as I said, all relevant national, state and
 17 local permits must be secured. The power purchase
 18 agreement must be either executed or, at least to
 19 a certain degree, project financing must be in place.
 20 So this is the actual gelling up of the whole project at
 21 this stage. Then you know that you have something
 22 viable going ahead now.
 23 Slide 16. And next we go to the construction
 24 design. Normally, when a project is tendered and the
 25 contractor comes in, during construction there is

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1 actually a little bit of tweaking, generally speaking;
 2 generally, and I'll qualify that. There is generally
 3 a little bit of tweaking in design that you have done at
 4 the tender stage, unless there are changed conditions
 5 which are exposed during construction, or come to light
 6 during construction. Then, if they are substantial --
 7 small changes are no problem. But if they are
 8 substantial, then you have to change the design, and
 9 this could be substantial. Like you may have to add --
 10 if your hydrology tells you something, you may have to
 11 add another spillway, or increase the capacity of your
 12 spillway.
 13 So I'll give you three recent examples in which, at
 14 the construction stage, we had to change the design.
 15 Going back to Mangla Dam, I'm sure you're aware it's one
 16 of the largest projects. When the construction started,
 17 the designers were Binnie and Partners, and Atkins was
 18 I think the contractor.
 19 When they started the project, the foundation
 20 revealed that the clays were sheared. Actually, from
 21 there, the concept of sheared clays and their lower
 22 shearing resistance came into being in the area of soil
 23 mechanics and geotechnical engineering. And
 24 Professor Alec Skempton of Imperial College actually was
 25 engaged in those studies. And because of that, because

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1 of the lower shearing resistance which was found during
 2 the construction phase, we had to change the design of
 3 the dam, with much flatter slopes to make it safe.
 4 Now, at Basha that I'm involved in, there are many
 5 changes that we had to make. For example, during the
 6 time the detailed design was done, which was something
 7 year 2012 or 2011, the "guidelines", I call it -- the
 8 International Congress on Large Dam guidelines -- on
 9 earthquakes changed. From 50 percentile, they went to
 10 75 percentile or 80 percentile for the selection of
 11 safety evaluation earthquake, SEE, or what was
 12 previously called the maximum credible earthquake, or
 13 MCE.
 14 So our design earthquake, or the maximum credible
 15 earthquake, or the safety evaluation earthquake, which
 16 is called SEE or MCE, changed from a value of 0.46g,
 17 which is the gravity value, to 0.64g, a 50% increase.
 18 So you can imagine what effect that had on the design.
 19 You had to apply that earthquake to all the features of
 20 the project -- during the construction phase, by the
 21 way -- to see that it was safe or not.
 22 Similarly, in the diversion, we had to change a lot,
 23 because during investigation we found out that the
 24 diversion canal was passing over alluvium, and such high
 25 flows could not be allowed over alluvium. So we had to

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1 change the alignment of the canal with an additional
 2 3 million cubic metres of rock excavation. And the
 3 canal is now totally running on solid gabbro granite rock,
 4 which is the main rock in that area, and so we are safe
 5 in that sense.
 6 Then we found out that the rock stresses in the area
 7 were different, and that has a major effect on the
 8 orientation of the powerhouses. Previously, it was
 9 reported that the main stress in the area in the rock
 10 was vertical. We found out: no, it is horizontal.
 11 Vertical always told us there was something wrong there,
 12 vertical could not be, maximum rock stress being
 13 vertical did not make sense. So we found out through
 14 over-coring test, and all other hydraulic fracturing,
 15 and things like that, that it, maximum rock stress, is
 16 horizontal. And based on that information, we had to
 17 reorient our powerhouses.
 18 And also the spillway. When we applied the
 19 earthquake forces on the dam with the excitation, we
 20 found out that this spillway was previously
 21 a crest-gated spillway. Now, we found out those gates
 22 would not withstand the amplification: with that
 23 amplification, they would fly off the trunnion support,
 24 you know, basically. So we then went for an ungated
 25 spillway.

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1 Not only that, but the sedimentation studies that we
 2 have carried out, we have mid-level outlets now for
 3 sediment venting, that is opening in the dam body at
 4 various levels.
 5 So all these changes are being made in the project
 6 as it is being built. So it is like making the aircraft
 7 as it is flying, you know? So sometimes this is how the
 8 challenges are in a hydropower project.
 9 The other example is of course of Neelum-Jhelum,
 10 where you're going to visit. And there were a lot of
 11 design changes made in this project during the
 12 construction process. And as you go to the site, and
 13 people will be giving you presentations, they'll be
 14 telling you about all those design changes that were
 15 required. And they were substantial, they were not
 16 minor.
 17 So at the end of the project or the construction,
 18 then we produce what are called the "record drawings" or
 19 "as-built drawings", because there are minor details
 20 which are slightly different than the tender drawings or
 21 the construction drawings that were issued, like half
 22 an inch there, a few millimetres there and a few
 23 millimetres there. So to have a proper record of what
 24 is there, there's a whole big set of drawings that is
 25 produced which is called "as-built" or "record

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1 drawings".
 2 This shows part of the drawings of Neelum-Jhelum
 3 orifice spillway, one of the drawings that was produced.
 4 So this is just a snapshot of that.
 5 Now, unless you have any questions, sir, I will
 6 pause here, because we then move to the next part of the
 7 presentation.
 8 THE CHAIRMAN: No questions from us. This was a very
 9 helpful presentation. So please, I think we're on to
 10 Mr Malik. Thank you very much though, Dr Hayat, it was
 11 very, very helpful.
 12 DR HAYAT: Thank you, sir. You are most welcome, sir.
 13 MR MALIK: Mr Chairman, members of the court, good
 14 afternoon. It's late afternoon now.
 15 My name is Muhammad Ayub Malik. I am associated
 16 with this project since 2009, very early in the project.
 17 We just started construction of the project when
 18 I joined, and I'm still here. So a lot of things have
 19 changed, whatever he has been telling, a lot of changes,
 20 a lot of challenges. And we'll be telling you a little
 21 bit on this one.
 22 My presentation is in two parts. One is I will take
 23 you through the basic hydroelectric components, very
 24 basic. My colleagues later on, at the dam site and at
 25 the powerhouse, will be telling you in details about

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1 because it can damage the foundations when the water
 2 goes over it, damage your equipment. It's very costly
 3 to fix.
 4 Next slide, please, 18. So this is a basic
 5 schematic of a hydropower project. I'm sure you will be
 6 seeing these sort of drawings quite a few times in the
 7 next two days. This is a dam which we put in the river
 8 to create a reservoir.
 9 This looks very steep, but if you look at the
 10 longitudinal cross-section of Neelum River, it's almost
 11 like this: it's a very steep river. And we have got --
 12 within a very short time, if you go on our reservoir,
 13 you will reach the flowing river. So it's 3 kilometres
 14 and you reach the reservoir. In case of storage dams,
 15 you can go 100 kilometres and you still don't see the
 16 river, it's still a reservoir.
 17 We have an intake from where we take the water.
 18 I'll explain later on their functions, later on. From
 19 there, the water is drawn into a filling basin, which
 20 is, in our case a desander. From the desander, the
 21 water enters the headrace tunnel. This looks very
 22 short, but in our case it's 28.5 kilometres, so it will
 23 give you a ... you can imagine the scale.
 24 At the end of the tunnel, we have a surge tank,
 25 which is a sort of pressure release valve so, in case of

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1 those things.
 2 And then I'll tell you the construction challenges
 3 of building a hydropower project in this area. And this
 4 will be based on the Neelum-Jhelum: pictorial things,
 5 what are the challenges, how we managed things. As
 6 Dr Tahir Hayat says, we have to come up with innovative
 7 ideas while designing and constructing these projects.
 8 I mean, there are places where you have got not
 9 enough space. Like if you go to the Neelum Valley, when
 10 you go to the project site, it looks huge. But when we
 11 were constructing it, we were seeing: how are we going
 12 to build it? It's only 50 metres wide. So you have to
 13 excavate it, you have to build that thing. So whether
 14 you can put a gated spillway there, or you have to have
 15 an ungated spillway.
 16 If there is sediment, you might have to go for
 17 a desander that we opted for in this project. We have
 18 another project where they said, "We don't need
 19 a desander, our reservoir is good enough to act as
 20 a desander".
 21 Then if there is a very windy area, then you have to
 22 make sure that your wave action doesn't make the water
 23 overtop the dam. This is something that most of the
 24 design engineers don't want their dam to do. Even for
 25 the concrete dams, they don't want them to be overtopped

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1 a sudden closure on the tunnels, the water doesn't
 2 damage the tunnels. And from there, the water goes into
 3 the penstocks, which are highly pressurised, so most of
 4 the time they are steel-lined. And that is connected to
 5 the spiral casing through an inlet valve, which is
 6 another safety thing, safety valve.
 7 The water goes into the turbine, it rotates the
 8 turbine, and it generates -- it converts this hydraulic
 9 head into mechanical power. And this mechanical power
 10 then rotates the generator, which converts this
 11 mechanical power into electrical power.
 12 And this electrical power then is sent to these
 13 transformers, which steps it up for the transmission
 14 voltage, which can be 132 volts, 220, 500. In our case,
 15 it's 525 volts, which is our national grid voltage.
 16 Next please, 19. I'll start with individually the
 17 components of the structures. Which is the dam? The
 18 dam's purpose is to create a barrier in front of the
 19 river and impound water behind it. It can be different
 20 types of dam: it can be made of concrete, it can be
 21 earthen dam, or it can be a combination of
 22 concrete-faced rockfill dam, which is a combination of
 23 both of these. The selection depends upon your
 24 location, availability of the material, and what is
 25 suitable for your environment. Earthen dams are

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1 normally built where you have got wide valleys, because
 2 they can take a lot of pressures. Concrete dams,
 3 normally you go for narrow valleys where you go for
 4 concrete dams, like in our case, in the Neelum-Jhelum
 5 River.
 6 Next, please, 20. So these are the basic three
 7 types of dams which I just discussed. The middle one is
 8 the basic earthen embankment dam, which is
 9 an earth-filled dam. Now, an earth-filled dam will have
 10 the tendency that the water can pass through the dam and
 11 it can damage the dam. So you put in an impervious
 12 core, which is generally clay core, or you can have
 13 an asphalt core that will stop the water migrating from
 14 upstream to the downstream side. Still some water might
 15 migrate from this core, so you put in sand drains on the
 16 downstream side so that it doesn't have a catastrophic
 17 failure of the dam.
 18 Second is your concrete dam, which can be either
 19 gravity dam, massive concrete, or you can have an arch
 20 dam, which is a thin structure, but if you have strong
 21 abutments then you can put an elliptical-shaped
 22 structure that can transfer the forces to the abutments.
 23 The third type is your concrete-faced rockfill dam,
 24 where you make the (indistinct) of crushed rock, and
 25 then you put on top, on the upstream face, concrete

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1 basic spillway designs. One is surface spillway. That
 2 means basically there's an opening on top of the dam
 3 with no gates there. The water, as soon as it reaches
 4 the full pondage level, it can start flowing over the
 5 dam. The operators have no control over this water, at
 6 what time they can release or how much they want to
 7 release. So this is dependent upon the flow in the
 8 river.
 9 A similar spillway, if you put a radial gate on top
 10 of it, becomes a crest-gated surface spillway. With
 11 this one, the operator has got two advantages: he can
 12 control the flow going over the reservoir, over the dam
 13 body, and he can raise the water that is stored behind
 14 the dam by the height of this opening, with a gate. So
 15 this is the crest-gated surface spillway.
 16 And the third one is where you put the spillway deep
 17 in the dam body. This has the advantage that you can
 18 have smaller gates because you can pass a similar amount
 19 of water because it has got a pressure on it to pass
 20 through. But it comes with its own problems: your gates
 21 have to be much stronger, you have to make sure that you
 22 don't have -- the velocities of water coming out are
 23 much higher, so your downstream concretes and the ogee
 24 surfaces have to be catered for that one.
 25 Third problem is that they, by virtue of their size,

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1 slabs. That will act as an impervious barrier to the
 2 water.
 3 On all three sites, three types of dams, you have to
 4 put cutoff walls with it so that the water doesn't seep
 5 under the dam. Anything that can seep under the dam can
 6 undermine the dam foundations. Their purpose is to
 7 elongate the seepage part so that the water that comes
 8 out from the downstream side comes out a long way down
 9 the dam side in the river.
 10 21, please. Spillways. Spillways, like the name
 11 suggests, it is a structure to spill or release flood
 12 waters to the river from the structure. Now, this
 13 picture is a spillway of the Tarbela Dam, the main
 14 spillway of the Tarbela Dam. I think its capacity is
 15 something like 840,000 cusecs, a huge capacity --
 16 860,000 cusecs. So this is a huge structure. It's
 17 amazing to see the water flowing from this one when it's
 18 flowing.
 19 Now, this can have different types of spillways.
 20 I'll explain in the next slide. But this is
 21 a crest-gated spillway, like Dr Tahir Hayat was saying
 22 that they had initially planned for the Diamer Basha
 23 project, where you can control the amount of water
 24 flowing from the reservoir.
 25 Next, please (22). These are the three types of

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1 they are limited to the maximum design capacity. So in
 2 case of an exceptional flood, they are then combined
 3 with either surface spillway or a gated spillway on top,
 4 so that there's a combination of both gates, or three
 5 types of gates, for the safety of the dam.
 6 [Slide] 23, please. Now we come to the intakes.
 7 The intakes are the structures through which you take
 8 the water from your reservoir and you take it into the
 9 tunnels or the conveyance system. The run-of-the-river
 10 projects have a problem that they are susceptible to
 11 sedimentation. So you want to take this water as high
 12 as possible from the reservoir. Because when the river
 13 flows, the sediments are mainly -- as you go up in the
 14 reservoir, the sediments are less and less, final
 15 sediments. Most of the sediments are at the bottom or
 16 in the lower part of the reservoir.
 17 But if you take -- so you can have a surface intake.
 18 But in case of a storage dam, you can even go for deep
 19 intakes, because by virtue of the reservoir being [so]
 20 long, most of the sediment settles many kilometres or
 21 tens of kilometres away from your intake structures.
 22 Next slide (24). There are two types of intakes in
 23 the run-of-the-river. One is you can have a deep
 24 intake. But the problem with that one is that your silt
 25 slowly migrates near your intakes, and they can then

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1 start migrating into your tunnels, which can damage your
 2 electromechanical equipment.
 3 For that, you go for a surface intake. In case of
 4 surface intake, you cannot put it too high because you
 5 can draw air in the intake. So in this case, you have
 6 a separation between your tunnel intakes and the intake
 7 from the reservoir, so that your clean water comes in
 8 and then you've got the water intake coming from the
 9 tunnel.
 10 In case you've got more silt, you can put a desander
 11 in between, which is a long settling pond for the
 12 sediment to settle down. We have got a settling pond;
 13 you just saw a picture in Mr Joya's presentation
 14 earlier, and we'll be showing you tomorrow those
 15 settling points.
 16 Next slide (25). Now, the conveyance elements. To
 17 take water from the intake to the powerhouse, you have
 18 got tunnels, canals, and then you've got penstocks. And
 19 right next to the powerhouse, you will have this inlet
 20 wall.
 21 This is a picture of the inlet valve of our
 22 Neelum-Jhelum project. The penstock terminates here.
 23 From there, it's connected to the inlet valve, and the
 24 inlet valve is then connected to our scroll casing,
 25 which takes the water into the turbine.

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1 have a 3.5-kilometre tailrace tunnel, which is
 2 unpressurised -- or low pressurised. I won't say it's
 3 unpressurised, but it has got only 20 metres of head on
 4 it.
 5 Next, please (27). Now I come to the turbines.
 6 Now, turbines are the elements that convert hydraulic
 7 head, hydraulic power into mechanical power. Now, we
 8 have got two main types of turbines: Francis and Pelton.
 9 Francis turbine we call the "reaction turbine", and the
 10 Pelton we call the "impact turbines".
 11 Now, in case of a Francis turbine, the water comes
 12 in through the spiral casing and you see the diameter
 13 reducing gradually. That is so that the water enters
 14 through these guide vanes. The turbine sits here. This
 15 is during the construction. And as water goes in, it
 16 maintains the pressure while the water keeps on getting
 17 in, and it hits the turbine runner and it rotates. And
 18 then it's connected on the top to a shaft with
 19 a generator that rotates and generates electricity.
 20 Next, please (28). As I was saying, there are two
 21 main types of turbines. One is the reaction turbine,
 22 where the water comes in through the spiral case, which
 23 you just saw the picture. It goes in, rotates the
 24 Francis runner, and then the water goes down into the
 25 turbine. This whole system is pressurised. And this

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1 These are designed so that, in case of an emergency,
 2 they can shut down. They have got these massive
 3 counterweights, which are 20 tonnes. So in case you
 4 have an electricity failure or something, they can just
 5 drop on their own under gravity. So they've got a big
 6 ball valve inside that rotates, with that load dropping
 7 down. This is required in case of a problem in the
 8 powerhouse; or you want to do some maintenance on one of
 9 the units, and you want no water flowing in because you
 10 have to send your technicians into the turbine to [do]
 11 maintenance or checking the conditions of the units.
 12 Next [slide] (26). Now, these are the various
 13 conveyance elements. We have got a headrace tunnel. In
 14 our case, it's headrace tunnel. But in case of some of
 15 the projects, we have got a channel also. It can be
 16 an open channel also. Like Ghazi Barotha, we have got
 17 a 52-kilometre-long power channel. Here, we have got
 18 a 28.5-kilometre pressurised tunnel.
 19 Then we have got the surge tank, and we have already
 20 told you. I will show you the pictures of this surge
 21 tank later on. We have got a surge shaft. In our case,
 22 we have a shaft which is 353 metres high.
 23 From there, we go to the penstocks. And then after
 24 it generates electricity, the water is taken out to the
 25 tailrace tunnel, back to the river. In our project, we

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1 pressure is equivalent to the pressure you have got in
 2 your system; which is, in our case, 420 metres of head.
 3 Whereas in case of a Pelton wheel, you have got
 4 a nozzle and a needle valve, which sprays a jet of water
 5 on these buckets or cups. And this rotates this wheel,
 6 and there's a horizontal shaft connected to a generator.
 7 Now, the advantage of this one is there's no
 8 pressure in it -- it's not pressurised, it's normal
 9 pressure -- and it is very simple to maintain. So if
 10 you have damage on one of these buckets, you can easily
 11 disassemble, repair and put it back in a day or two.
 12 Whereas in case of a Francis runner, normally you have
 13 to take out the generator -- which weighs something
 14 like, in our case, 400 tonnes plus -- you have to take
 15 it out, you have to take out the shafts, then you remove
 16 the runner, and then you can repair it.
 17 But in Neelum-Jhelum project, they made some
 18 changes. They have introduced a part of the draft tube
 19 that can be taken out at the bottom, and the runner can
 20 be dropped at the bottom. So it is one third the time
 21 you can take it out. And if you want to replace it or
 22 do some major repairs on the runner, you can do it, in
 23 our case.
 24 29, please.
 25 DR BLACKMORE: On the Francis turbine, do you have coaster

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1 gates on it that regulate the flow?
 2 MR MALIK: Yes, we have got the gates. We have got the
 3 wicket gates. We call them "wicket gates".
 4 DR BLACKMORE: What do you call them?
 5 MR MALIK: "Wicket gates".
 6 DR BLACKMORE: "Picket"?
 7 MR MALIK: "Wicket".
 8 DR BLACKMORE: Ah, well, that's Australian!
 9 MR MALIK: We got it from the British!
 10 DR BLACKMORE: Ah, I can't comment on that!
 11 MR MALIK: So with that, you can adjust the opening and the
 12 water that goes in, how much you want to open it. Our
 13 turbines are at 300 rpm. They run at 300 rpm.
 14 Next, please (29). The last element, once you
 15 generate electricity, you can't see this, the
 16 3.5-kilometre tunnel that discharges the water back to
 17 the river.
 18 Now, this is the outlet structure. You were saying
 19 that you might have seen it. It is visible. When you
 20 are travelling on the road, you can see this part,
 21 because you are travelling on top of this road. So you
 22 have seen this one.
 23 So this water is then diverted back. It's conveyed
 24 back to Jhelum River. So basically the water, you can
 25 touch it. It's coming from Neelum, untouched by

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1 anything else, and now it's going into Jhelum River
 2 after 31.5 kilometres.
 3 Next, please (31). Now I'll give you a small
 4 overview of the construction challenges that we have
 5 gone through during construction of this Neelum-Jhelum
 6 Project, five/six slides. It took us ten years, so ...
 7 to build it! Not to take the slides, but it took us ten
 8 years to build the project. And we had to go through
 9 2010 flood, not shown here. We were just very early,
 10 and we had a huge flood, and our diversion tunnel was
 11 not connected yet, and it got filled up with sand so the
 12 contractor has to go back and dig it out again. So it
 13 was big challenges from day 1.
 14 Next, please (31). As I said, it took us ten years
 15 to do it. Our major challenges during construction was
 16 diversion and excavation. This is our diversion dam
 17 during construction. You will be seeing only this much
 18 portion when you will go there, hardly the top
 19 10 metres. The rest of it is underwater now.
 20 Then we have got the tunnelling. The biggest
 21 challenge on this project was tunnels, because we had in
 22 total 58-68 kilometres. It has got the main tunnels,
 23 our diversion tunnel, our tailrace tunnel, and we had
 24 about 15 kilometres of access tunnels, which were
 25 excavated just to reach the main tunnels, and which were

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1 abandoned later on.
 2 And then the surge shaft, I said 353 metres high.
 3 And the powerhouse. Powerhouse is a huge cavern
 4 that we have to go and -- and like Dr Tahir Hayat was
 5 saying, there were changes. In this case, we had to
 6 change the orientation and the location of the
 7 powerhouse before we started excavating.
 8 Next, please (32). The first one was to divert the
 9 Neelum River. This is our construction site. So to
 10 make it dry or make it free of water, we excavated
 11 a diversion tunnel on the right bank, 505 metres long.
 12 This, you can see on the right side, is the water coming
 13 out from the diversion tunnel. On the bottom left side,
 14 this is the foundation concretes for the main structure
 15 of the dam.
 16 And incidentally, if you see this long wall, during
 17 construction we realised that this water that we can
 18 divert to the river is not enough, so we'll be
 19 overtopped, our coffer dams will be overtopped. So we
 20 came up with the idea to use this area on the right side
 21 as an open channel. And we built a longitudinal coffer
 22 dam, and put RCC, roller-compacted concrete flooring
 23 here, on which we'll later on build one element, which
 24 was the rockfill dam on this part. Rest of them was
 25 concrete dam.

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1 So we used this thing, and we were able to pass
 2 1,500 cumecs during construction, without overtopping
 3 our coffer dams.
 4 Now, this left side you see is the excavation for
 5 the desanders. And this block you see is basically the
 6 opening of the tunnel. This is the start of our tunnel.
 7 Now, when you'll go there, we have got a collecting
 8 tunnel here and the desander built at this place.
 9 Next, please (33). Now, for the tunnelling, we
 10 started this tunnelling with what we call the
 11 conventional drill and blast method. We started that
 12 thing. But very early this in the project, we realised
 13 that there is a stretch of 12.5 kilometres where there's
 14 no access tunnel available in between them. And that
 15 was the critical most part where going with a drill and
 16 blast would have been very slow, because the drill and
 17 blast produces a lot of noxious gases, dust, and it's
 18 a slow process.
 19 So WAPDA decided to acquire these hardrock
 20 tunnel-boring machines, two of them. And they were
 21 acquired -- brought to site in 2012. They started
 22 excavating. This is 8.5-metre diameter tunnel TBM.
 23 They were, I would say, running factories, 185 metres
 24 long. So it was like a snake going through the tunnels
 25 excavating, chewing up the rock.

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1 Our tunnels, the lowest point was when we passed
 2 under the River Jhelum. You saw the drawing where the
 3 river comes in from -- on the inside, we call it "upper
 4 limb"; and then it goes to Muzaffarabad, and then comes
 5 back lower limb. So the tunnel came from Neelum River,
 6 it went under the Jhelum River, and then it discharged
 7 into Jhelum River. So we were around 178 metres under
 8 the Jhelum River.

9 Next, please (34). Now I'll show you the profile of
 10 our tunnels. This is the dam site where the Neelum
 11 River is flowing. From here, this is how our tunnels
 12 were. You see the profile of the tunnel. This part of
 13 the tunnels have a very -- I would say gradient is very
 14 less because we used the TBMs on that. TBM has -- I was
 15 told that they have a restriction, or they can't go
 16 above 6% gradient, these light TBM. So the TBM
 17 incidentally started here, just downstream of this added
 18 A2, and we excavated up to here with the TBM tunnels.
 19 And you can see the overburden. At the highest point,
 20 it was around 1.5 kilometres of overburden on top of the
 21 tunnels.

22 From here, the tunnels go in a steep slope. In the
 23 original design, this dotted line, this was in the
 24 original concept or feasibility design, because the
 25 tunnel engineers say that you need to have sufficient

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1 the Jhelum crossing, they come back and they again merge
 2 into one tunnel.

3 These tunnels are 8-metre diameter excavated, and
 4 then they were concrete-lined. All the tunnels which
 5 were done by drill and blast are concrete-lined. The
 6 tunnels that were excavated with the TBM are
 7 shotcrete-lined.

8 Next, please (36). This is the steel liner factory.
 9 I told you under the Jhelum River we put in the steel
 10 liner. These are 6.6-metre diameter steel pipes. We
 11 used to call them "cans". And each piece was 12 metres
 12 long, 72 tonnes of weight. It's 38-millimetre
 13 high-grade steel. And these were transported through
 14 low-bed carrier from this factory inside the tunnel
 15 where they were to be placed. And then they were
 16 offloaded on a rail carriage which will take them where
 17 they were to be installed. And there, they were welded
 18 together. And once they were all welded together, they
 19 were filled up with concrete from outside.

20 Next, please (37). This is the surge shaft I was
 21 telling you. And for comparison, we put the
 22 Eiffel Tower along it. Eiffel Tower is 330 metres high.
 23 Our surge shaft is 353 metres.

24 Yesterday somebody asked me from Chicago, they were
 25 doing another exercise, and they say in Scotland they

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1 rock cover on top of you to have a safe tunnel. So the
 2 designers had this thing 400 metres below the river.

3 But with this thing, the gradients were coming out
 4 more than 14% so our electromechanical -- our
 5 earth-moving machine couldn't drive on 14 degrees with
 6 mud and wet ground. Plus it was very -- it was found to
 7 be very difficult to drain out. And if it has got silt
 8 accumulated, it will choke the tunnels.

9 So it was decided to remove the tunnels -- remove
 10 this dip. We used to call it the "Jhelum Dip". So we
 11 moved it up, but then your rock cover became only
 12 178 metres. Rather, the depth was 178 metres, our
 13 geologist said the rock cover is only 100 metres.

14 So in this area we put in a steel liner to
 15 strengthen the tunnels. For 732 metres -- these are
 16 twin tunnels so we put 732 metres steel lining on both
 17 sides.

18 After that, the tunnel flattens out and it goes to
 19 the powerhouse, and from powerhouse this is our tailrace
 20 tunnel.

21 Next, please (35). Now, the twin tunnels. Our
 22 tunnels started as a single tunnel; I showed you in the
 23 dam picture. And after 0.8 kilometres it is split into
 24 two tunnels. So this is our tunnel bifurcation.
 25 There's another bifurcation where they come back. After

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1 are having a pump storage where they have got a surge
 2 shaft which is higher than Burj Khalifa. Burj Khalifa
 3 is 828 metres high, so you can imagine a surge shaft
 4 which is 828 metres high.

5 So this was a very challenging one because the
 6 contractor has to first drill a pilot hole coming down
 7 353 metres, making sure that it stays inside that tunnel
 8 geometry, although it veered off by 4 metres or
 9 5 metres, because to keep it straight is a very, very
 10 difficult job. And then at the bottom they put in
 11 a huge cutter, and then they took it up, which we call
 12 "raise boring". So it created a hole which was
 13 1.6 metre diameter. That was our mucking hole.

14 So then the contractor started excavating from the
 15 top, and he would throw all the rock in that hole, and
 16 he would haul it from the bottom. And once it was done,
 17 then it was concreted all the way up by slip forming.
 18 So it was a very complicated and dangerous job. Going
 19 down in an Elemac, it gives you religion! Especially if
 20 the Chinese are operating it!

21 But luckily we had no accident. Luckily we had only
 22 one accident, where somebody broke a leg. There was
 23 a stone that fell off and he had a simple fracture. But
 24 this project, I don't know why, but somehow with --
 25 I mean, I hear about other projects, safety ones. We

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1 had less than a dozen fatalities in 12 years of
 2 construction, and accidental ones. And half of them
 3 were traffic-related. Somebody drove off the bridge and
 4 the dumper went into the river, or somebody drove over
 5 somebody sleeping in the tunnel. I mean, people do it.
 6 It's idiotic but people still do it.
 7 The main accidental deaths were I think six or
 8 seven. Three we had an incident in the TBM, and five or
 9 six where the form work fell down.
 10 Next, please (38). Now, this is the powerhouse
 11 cavern. The powerhouse cavern, when we'll go tomorrow
 12 what you will see is 50% of the powerhouse. This
 13 powerhouse is 25 metres wide, and from the top to the
 14 deepest point is 54 metres, and the length is 137 metres
 15 long.
 16 So we excavated. Starting from the top, we
 17 excavated a pilot hole, started -- put a tunnel through
 18 the top, and then we took out the shoulders while we put
 19 in 15-metre long strand anchors to support the crown.
 20 And then we came down.
 21 When we came to this height, we put in these crane
 22 beams. In the original design, these crane beams were
 23 resting on concrete columns. But we said I mean, I was
 24 part of that, that if we ever do it, these cranes have
 25 to wait for two years. So we decided to put these crane

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1 beams by putting these cranes and anchoring these crane
 2 beams into the rock by 15-metre-long stand anchors and
 3 7.5 metre-long rock bolts. So these crane beams are
 4 designed to take a load of, I think, 600 tonnes.
 5 We have two bridge cranes running on that,
 6 275 tonnes each. At this elevation, our powerhouse,
 7 being such a wide one, and the geology is not the best,
 8 they started converging, the walls started moving in.
 9 Maximum I think we calculated was around 235 millimetres
 10 of movement on this wall, on the downstream wall. So we
 11 stopped the excavation. Contractor brought in around
 12 15,000 tonnes of muck inside, to build ramps and then
 13 install 15-metre-long rock anchors to stabilise the
 14 rock.
 15 Now we do -- I mean WAPDA and we have been doing
 16 regular measurements. There's no movement at all, it's
 17 stabilised.
 18 Next, please (39). That's all for the construction.
 19 Ten years in ten minutes! Any questions?
 20 PROFESSOR BUYTAERT: A slightly more general question on
 21 power generation. How is the power output of the
 22 generators controlled?
 23 MR MALIK: I have to ask my electrical engineers. I am
 24 a civil engineer; I don't go near the electrical parts.
 25 Mr Arfan [Miana]?

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1 MR MIANA: Can you repeat the question?
 2 PROFESSOR BUYTAERT: How do you control the power output of
 3 the generators?
 4 MR MIANA: The power from the generator is dependent upon
 5 the head and the flow rate. So if the flow rates are
 6 less then the power generation is obviously less. And
 7 the controlling is through our regulation of the wicket
 8 gates or the stairways, what you were describing over
 9 here. And the rest is the governor system, which
 10 controls the system frequency, as well as the speed of
 11 the turbine.
 12 So these are the parameters, which are
 13 interconnected and which control the output of the
 14 generator.
 15 PROFESSOR BUYTAERT: Thank you.
 16 DR BLACKMORE: I'm just interested in what was the design
 17 criteria for earthquake loading. What did you allow
 18 for? I'm assuming you allowed the same for the
 19 powerhouse, the tunnel and the structure, but I'm not
 20 sure what it would be.
 21 MR MALIK: I have to find out. We have changed -- when it
 22 was tendered, this project was designed -- original
 23 design was done in 1996. What happened was that in 2005
 24 there was a major earthquake. In 2007 the contract was
 25 awarded. But after they awarded the contract, based on

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1 that earthquake the Government of Pakistan changed the
 2 earthquake criteria for this part of the world. It was
 3 a 7.8 magnitude earthquake. So I can get you the
 4 seismic parameters from where -- we changed both
 5 underground parameters and the aboveground parameters to
 6 cater for earthquakes.
 7 DR BLACKMORE: So 7.8 was the number --
 8 MR MALIK: I think something around 9. Our maximum credible
 9 earthquake is 9 plus.
 10 DR BLACKMORE: Alright. Make sure --
 11 MR MALIK: Although somebody wanted it to be 10. But then
 12 somebody said, "If we have to design something for
 13 10" -- and I said one thing. I said: I'm not
 14 a seismologist, but if a 10 earthquake comes, your
 15 structure might be safe but there'll be no mountains
 16 around it! So then we settled for 9 plus, or something
 17 like that, one in a thousand year event, something like
 18 that.
 19 DR BLACKMORE: It's an extremely high number.
 20 MR MALIK: Very high number.
 21 DR BLACKMORE: Yes, it's a very high number.
 22 MR MALIK: I can get you the actual figures also.
 23 THE CHAIRMAN: I hope we don't test that number while we're
 24 here!
 25 MR MALIK: No! In 2016 we were having a meeting. Our panel

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1 of experts were here. We were sitting in the design
 2 office in Muzaffarabad and I was giving a presentation
 3 on the schedule of the project. And I have done hardly
 4 three lines when there was a sound like there was
 5 an accident on the road. Our building was right next to
 6 the main highway. And I thought there's an accident.
 7 And I turned around and everyone has disappeared. And
 8 then I realised that this was an earthquake.
 9 So I went out, and we were standing there, and you
 10 can see -- there's a vehicle showroom right next to that
 11 building, and you can see a wave going on the facade of
 12 that glass building, and it was for 30 seconds.
 13 Later on we found out it was a 7.4 earthquake. So
 14 when I came back, I commented: never again talk about
 15 schedule on this project: even the earth shakes!
 16 THE CHAIRMAN: Well, again, I hope we don't test that number
 17 here. I also hope that they're not constructing the
 18 aircraft as we're flying home!
 19 MR MALIK: It's already been constructed!
 20 THE CHAIRMAN: I had a few questions. This relates to the
 21 powerhouse, but it's a very basic one. It looked like
 22 there were at least two turbines there. How many --
 23 MR MALIK: Four turbines.
 24 THE CHAIRMAN: Four turbines.
 25 MR MALIK: Four turbines.

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1 At the end of the desanders is a collecting canal
 2 from where the water goes into the tunnel; so this is
 3 the left-hand structure. Underneath the desanders you
 4 see these small gates. These are called under-sluices.
 5 This is for flushing any silt that accumulates in front
 6 of our intake structures.
 7 In the middle, these are our orifice spillways.
 8 These are three gates. And we have to design these
 9 gates so that in case of an emergency, even if one gate
 10 is out of order, these can pass the maximum flood. This
 11 is called "N minus 1 criteria" on any dam. So these
 12 gates are huge. In Pakistani standards, normally our
 13 gates are 12 metres by 8 metres. Our standard gates on
 14 most of our projects are 12 metres by 8 metres. These
 15 are 12 metres by 15 metres: 12 metres wide, 15 metres
 16 high.
 17 Then on the right, which is under construction --
 18 you don't see it here -- is -- we call it debris
 19 channel. This has got -- this is crest-mounting gates
 20 and it's got flap gates. The radial gates, they move
 21 like this upwards, and the water goes below that. The
 22 flap gates are like this and they fall down.
 23 Basically, in this reservoir, in case of floods, you
 24 get a lot of floating debris. And especially sometimes
 25 when you've got exceptional floods, you get these logs

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1 THE CHAIRMAN: And the value of having multiple turbines is
 2 not to use them all at once; is that correct?
 3 MR MALIK: No, if we have full water supply available, like
 4 in high-flow seasons, and our dam can supply 280 cumecs
 5 to the powerhouse, we can run all four units flat out.
 6 THE CHAIRMAN: Okay. So you would in some situations run
 7 all of them?
 8 MR MALIK: We run them for five months a year usually,
 9 although WAPDA have their own criteria for running the
 10 project that, after certain hours of running, they stop
 11 one unit for a day, and they do a monthly maintenance on
 12 all of them. But as a routine, they run those turbines
 13 flat-out for five to six months, as long as the water is
 14 available.
 15 THE CHAIRMAN: The next question is relating to slide 31, so
 16 if Mr Miles could take us back to that. Could you just
 17 point out, using your pointer, the basic components?
 18 I find this photograph very helpful because it strips
 19 away the water. The basic components of the dam.
 20 MR MALIK: This is looking downstream. This is the left
 21 bank, this is the right bank of the river. These are
 22 the intakes, this is the intake structure from where we
 23 take the water. These are the intake gates. The water
 24 goes into the desanders. What you see behind it being
 25 constructed are the desanders.

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1 coming in because there's a big logging industry going
 2 on in the upper reaches. So you get logs. So to pass
 3 them through this structure, you lower the gates and the
 4 water takes these debris downstream. So these are the
 5 three ...
 6 And then on the right of this structure, where you
 7 see this wall going, this is where we built a rockfill
 8 dam, which is a flexible dam. The reason is that this
 9 line where you see this wall, this is where we have got
 10 a main boundary thrust. Our dam is situated on the main
 11 boundary thrust. When we'll go to the site, you will
 12 see that on the right the rock is greenish colour. On
 13 the left side it is greyish to brownish colour. This
 14 left side is Indian subcontinent tectonic plate. Right
 15 side is Eurasian plate. So you can stand there and your
 16 one foot is in India, the other foot is in Europe!
 17 It's not like that, but we have done it. When we
 18 excavated it we found a seam of very crushed rock. It
 19 was crushed to like powder. And when our people were --
 20 I mean, our geologists, when we did that foundation,
 21 they have to go and grout that at the bottom so that
 22 water doesn't come. They said in that area it was so
 23 dense that they couldn't even grout it.
 24 So this is an interesting area. This is Eurasian
 25 plate, and this side is Indian subcontinent. The Indian

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1 subcontinent, as per the tectonics, it's going beneath
 2 the Eurasian plate and that's why Himalayas are still
 3 rising.
 4 THE CHAIRMAN: But we don't need a visa to cross from one --
 5 MR MALIK: No, no!
 6 THE CHAIRMAN: So my last question was relating to the surge
 7 shaft, which I think was at slide 37. Could you just
 8 indicate: the idea here is not that there would be water
 9 that would go necessarily go all the way up and out the
 10 shaft?
 11 MR MALIK: No, no.
 12 THE CHAIRMAN: It's just a pressure release where there
 13 might be water possibly?
 14 MR MALIK: It contains water to the level where the dam
 15 water level is. Because the liquid maintains its level.
 16 So it's not like there is a lot there. So even if the
 17 water level in the reservoir is 1,000, the water in this
 18 tunnel will be 1,000. It has got another snake going on
 19 top of it.
 20 But that tunnel, our reservoir level, maximum level
 21 is 1,015 above sea level. This shaft has a tunnel on
 22 top of it. That has outlet at 1,040. So the water will
 23 be at 1,015 all the way in that tunnel. When the
 24 pressure comes, it's like that pump, and the water rises
 25 up in that one. And then if it is above 1,040, that

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1 tunnel opens on the side of the mountain and the water
 2 goes out.
 3 We have tested this phenomenon in 2019. It's part
 4 of the commissioning. We had four units running at
 5 full, and then we made a sudden shutdown of all four
 6 units. "Sudden" means within a minute. So it created
 7 a shock wave above. And we had people in the upper
 8 tunnel to monitor that. The water went maybe 20 metres
 9 higher than the normal and then it came down. So there
 10 was a surge going on. I was standing on the downstream
 11 of the outlet structure. Hardly a ripple came out. So
 12 it performed excellent.
 13 THE CHAIRMAN: You were looking in the outlet to see the --
 14 MR MALIK: No, I was standing at the -- there was a wall --
 15 there's a bridge on the downstream of that. This
 16 picture you saw, I took that picture from that bridge
 17 downstream of the outlet structure.
 18 THE CHAIRMAN: Okay.
 19 Did you have a question?
 20 DR BLACKMORE: Well, I was going to ask -- sorry, I do have
 21 one question. I'm just interested in how deep you had
 22 to drill your grout curtains. How far did you go down?
 23 MR MALIK: In the dam site?
 24 DR BLACKMORE: Yes, the dam site.
 25 MR MALIK: I think they were 25 or 30 metres. 24 metres?

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1 He's the geologist so he knows exact, but I knew that
 2 it's around 25 metres.
 3 DR BLACKMORE: That must be pretty good rock --
 4 MR MALIK: Yes.
 5 DR BLACKMORE: -- because I put them down 120.
 6 MR MALIK: No, we put it at 25. And then when we started
 7 raising the reservoir, for the first few months a lot of
 8 water came up from our drainage system in the drainage
 9 galley. But now hardly one third of that water is
 10 coming out, very little water comes out.
 11 MR MINEAR: First of all, Mr Malik, Mr Hayat, thank you for
 12 your presentations, they were very, very helpful.
 13 When we drove up this morning, we were looking at
 14 the Jhelum River, and it was both more turbid and
 15 a higher flow than I would have expected during this
 16 time of year. Am I right about that or is that typical?
 17 MR MALIK: No, it's normal. Mr Tahir Hayat is working on
 18 Indus River, which he says is fed by snowmelt.
 19 Similarly with the Jhelum River, but the Jhelum River we
 20 call it an "early riser". You can see the snow from the
 21 dining room.
 22 MR MINEAR: Yes.
 23 MR MALIK: Similarly you've got mountains on this side which
 24 feed into the Jhelum River, like on the inside, Srinagar
 25 Valley and all that. This snow is at a lower altitude,

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1 so it starts melting earlier.
 2 So in hydrological terms, the flow in the Jhelum
 3 River starts rising from 15th March, that's our
 4 criteria. In case of Indus, it is 15th May. So there's
 5 a difference between them.
 6 MR MINEAR: And can I ask you, do you know approximately
 7 what the flow of that river is in cubic metres per
 8 second right now?
 9 MR MALIK: I have no --
 10 MR MIANA: It's about 380 --
 11 MR MALIK: No, that is in the Neelum River. But what's in
 12 the Jhelum also?
 13 MR MIANA: Jhelum, I can get the data and [tell you]
 14 tomorrow.
 15 MR MINEAR: That would be great.
 16 MR MALIK: I've got another thing: if you see the river dark
 17 brown colour, that means most water is coming from
 18 Jhelum. If it's greyish, it's coming from Neelum. Both
 19 of them have different coloured waters.
 20 THE CHAIRMAN: So this talk of the Jhelum River prompts
 21 another question: why did you not build the powerhouse
 22 at the first -- the Jhelum dip, if you will?
 23 MR MALIK: The first feasibility done for this project had
 24 the powerhouse where we had the Jhelum dip: it was
 25 there. But at that time I think it was 560 -- 550 MW.

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<p>1 It was a 550 MW. This was in the feasibility studies. 2 And then there was another weir there that will take it 3 and bring it here, another 250 or something like that. 4 Later on there was another study, like Dr [Hayat] 5 said, that you keep on refining your inventory. And 6 they said that instead of having these two powerhouses, 7 you make one and you can get 969 MW here; and you put 8 another weir upstream of our Jhelum dip, and then you 9 have the Kohala hydropower project that generates 10 another 1,150 MW. So instead of having 1,000 MW, you 11 are now getting 2,000-plus MW. 12 THE CHAIRMAN: More head, basically, yes. 13 MR MALIK: Yes. 14 THE CHAIRMAN: Okay. Well, thank you very much, Mr Malik, 15 for your presentation. Thank you, Dr Hayat, for your 16 presentation. They were very helpful and very 17 informative. Thank you as well to Mr Miana for jumping 18 in in the midst to answer a question. We very much 19 appreciate all the work you put into these 20 presentations. 21 I think that brings us to the end of today's 22 session, so we will retire now, but with thanks to 23 everyone who's present. We very much appreciate all the 24 work you've put into this, and we're looking forward to 25 the next few days as well. Thank you very much.</p> <p style="text-align: center;">Page 105</p>	
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<p>1 (The day concluded) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25</p> <p style="text-align: center;">Page 106</p>	
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ARBITRATION PURSUANT TO ARTICLE IX AND ANNEXURE G OF THE INDUS WATERS TREATY 1960

Day 2 -- Site Visit

Wednesday, 24 April 2024

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