Freeboard

Dr Cameron Miles

Indus Waters Treaty (Pakistan v India), PCA Case No 2023-01

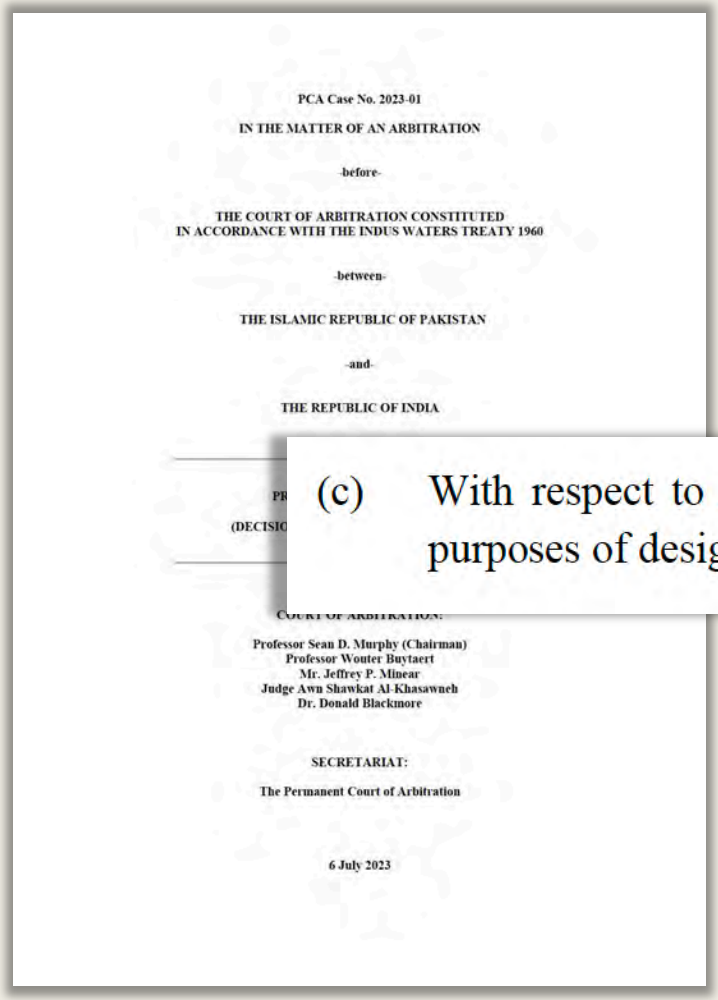
Hearing for the First Phase on the Merits

11 July 2024

Part I

Introduction

The Court's freeboard question



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

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

6 July 2023

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

PO6, ¶ 35(c)

Annexure D, Paragraph 8(a)

No. 6032

INDIA, PAKISTAN and INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

The Indus Waters Treaty 1960 (with annexes). Signed at Karachi, on 19 September 1960

Protocol to the above-mentioned
vember, 2 and 23 December 1

Official text: English.

Registered by India on 16 January 1962.

INDE, PAKISTAN et BANQUE
LA RECONSTRUCTION ET

Traité de 1960 sur les eaux de l'I
à Karachi, le 19 septembre 19

Protocole relatif au Traité susmentionné. Signé les 27 novembre, 2 et 23 décembre 1960

Texte officiel: anglais.

Enregistrés par l'Inde le 16 janvier 1962.

PART 3—NEW RUN-OF-RIVER PLANTS

8. Except as provided in Paragraph 18, the design of any new Run-of-River Plant (hereinafter in this Part referred to as a Plant) shall conform to the following criteria :

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

(*b*) The design of the works shall take due account of the requirements of Surcharge Storage and of Secondary Power.

Outline of submissions

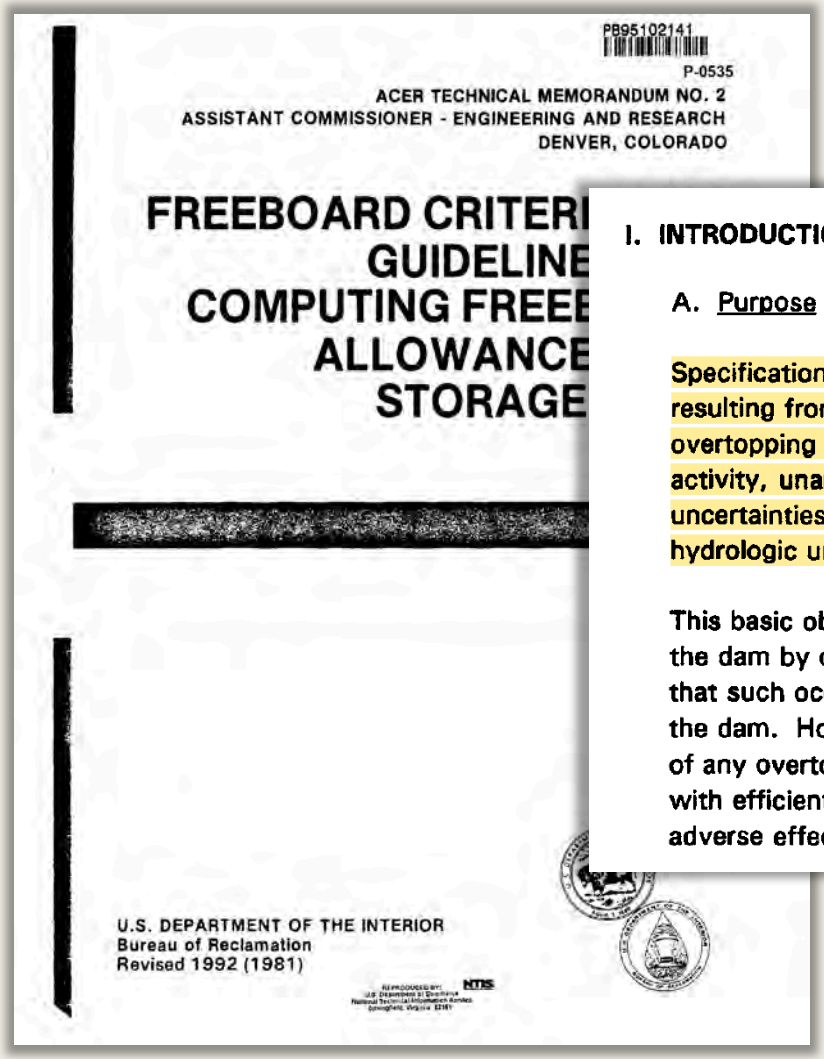
- **Part II:** The concept of HEP freeboard
- **Part III:** Interpreting Annexure D, Paragraph 8(a)
- **Part IV:** India's case on freeboard
- **Part V:** Answering the Court's question on freeboard

Part II

The concept of HEP freeboard

HEP freeboard

Purpose of freeboard



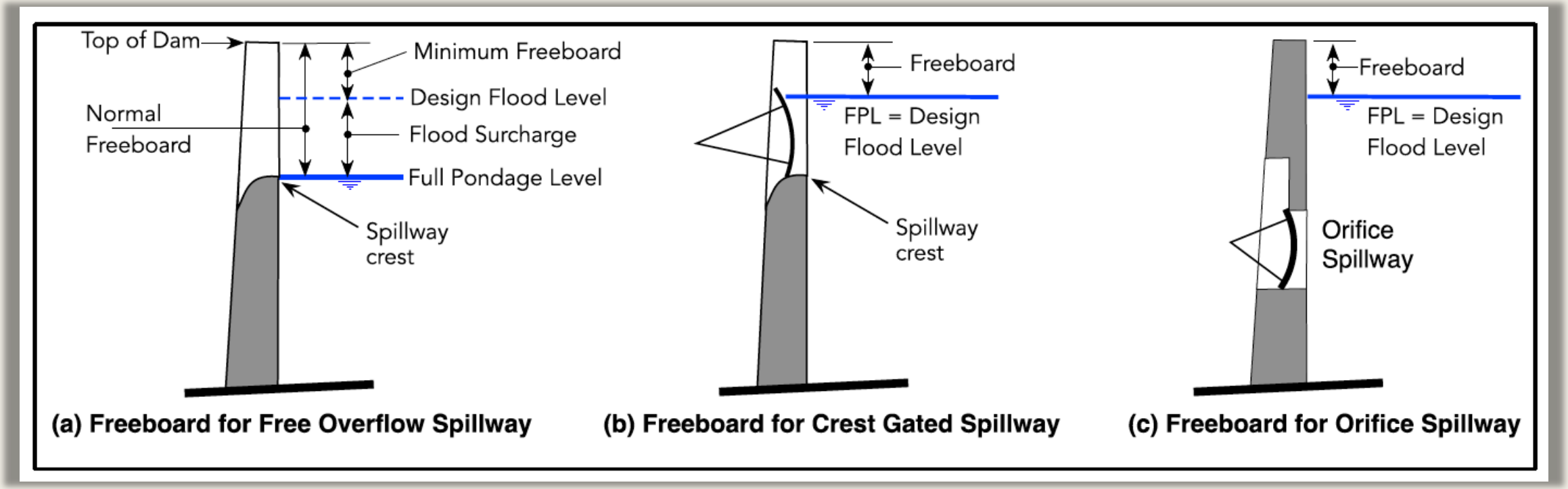
I. INTRODUCTION

A. Purpose

Specification of freeboard is critical in protecting downstream areas against possible hazards resulting from overtopping of a dam. The objective of freeboard is to provide defense against overtopping due to high reservoir inflows, wind setup and wave runup, landslides and seismic activity, unanticipated settlement of the embankment, malfunction of water release structures, uncertainties in the operation and maintenance of the dam and appurtenant structures, and hydrologic uncertainties.

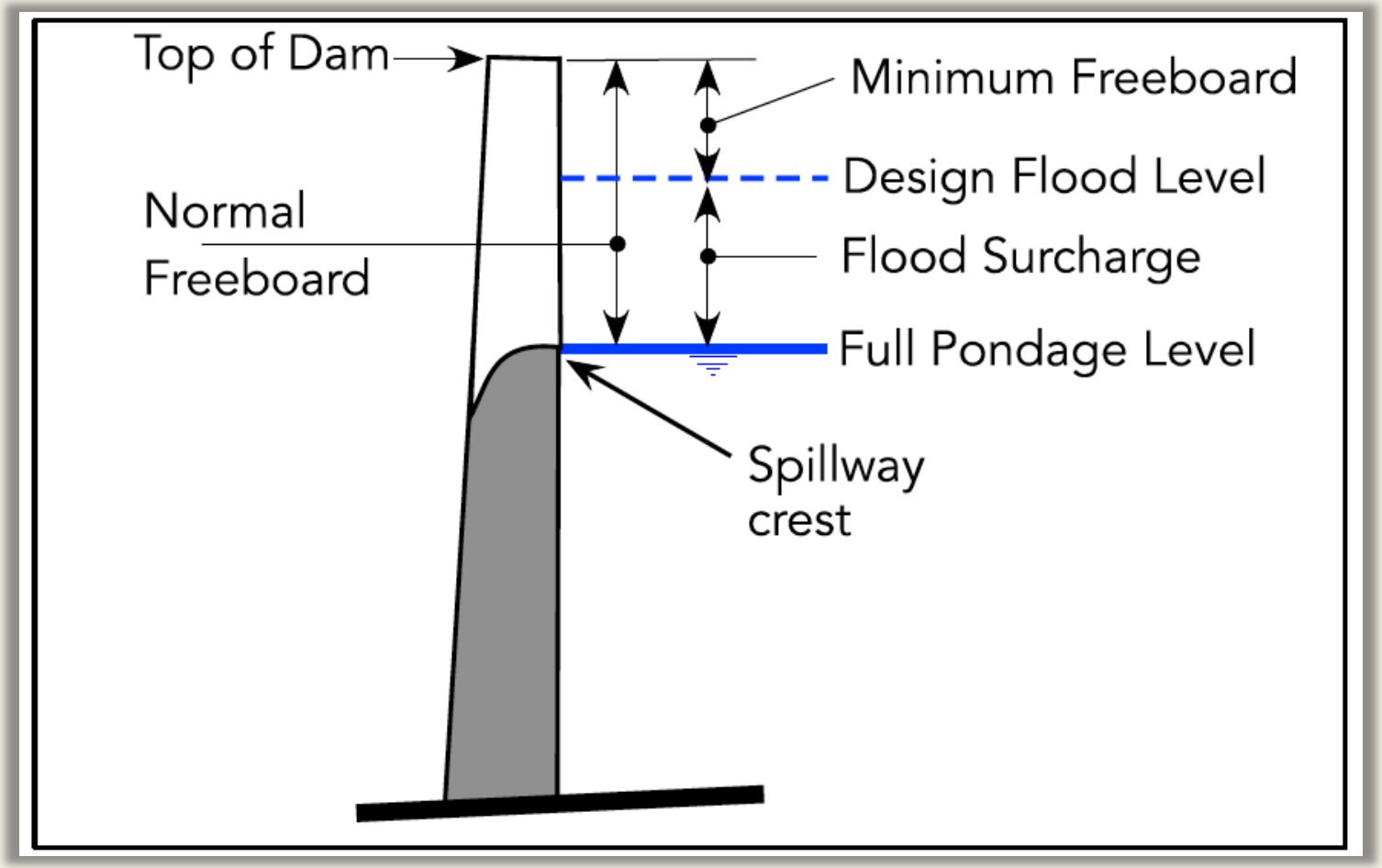
This basic objective of freeboard does not necessarily require total prevention of splash over the dam by occasional waves under full surcharge and extreme conditions, but does require that such occurrences will be of such magnitude and duration as to not threaten the safety of the dam. However, the objectives of freeboard allowance for dams should include prevention of any overtopping of the dam by either frequent or infrequent high waves that might interfere with efficient operation of the project, create conditions hazardous to personnel, or cause other adverse effects not necessarily associated with the general safety of the structure.

Freeboard and spillways



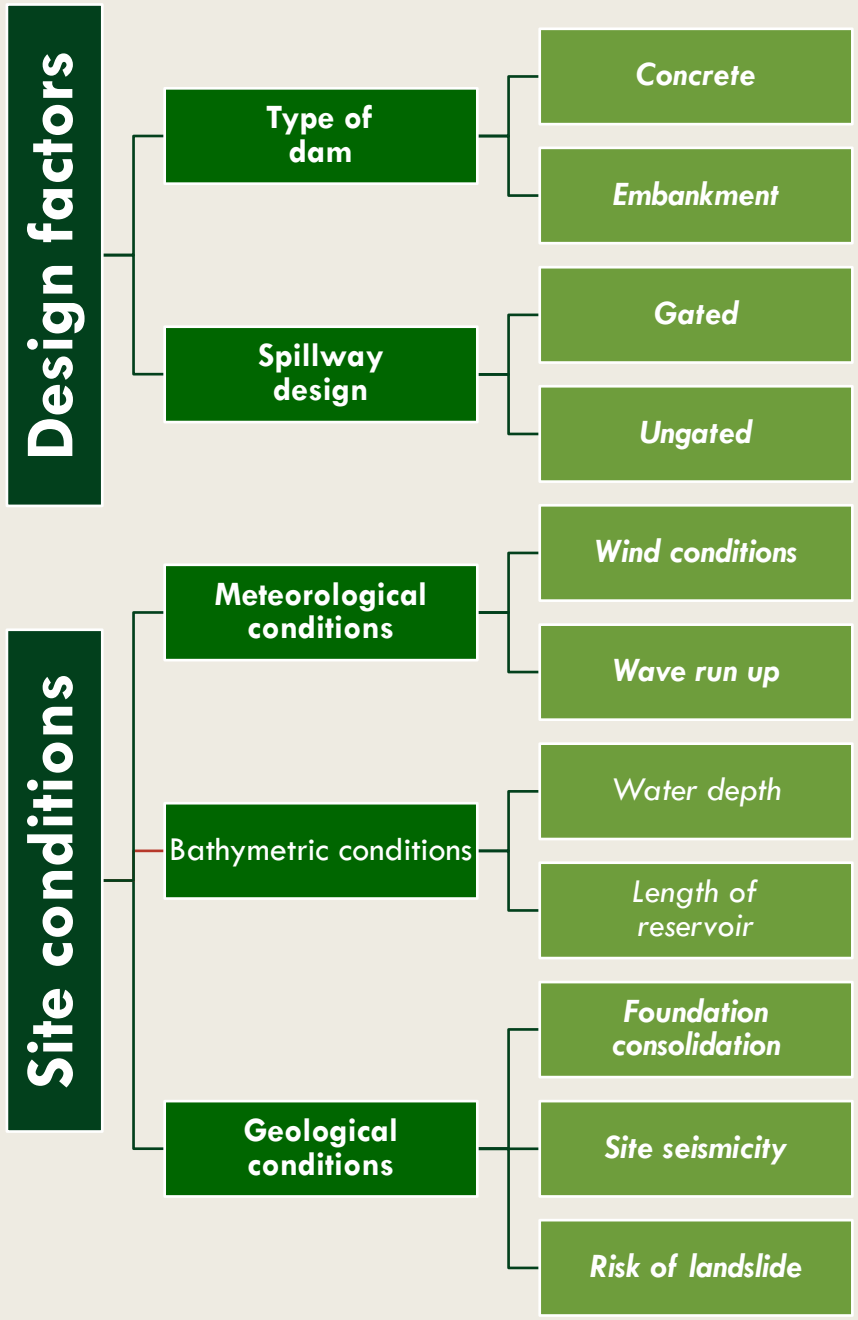
Memorial, fig. 4.26

Normal versus minimum freeboard



- **Normal freeboard:** full pondage level to top of dam.
- **Minimum freeboard:** design flood level to top of dam.

Memorial, fig. 12.1



Determining freeboard height

Part III

Interpreting Annexure D, Paragraph 8(a)

Annexure D, Paragraph 8(a)

No. 6032

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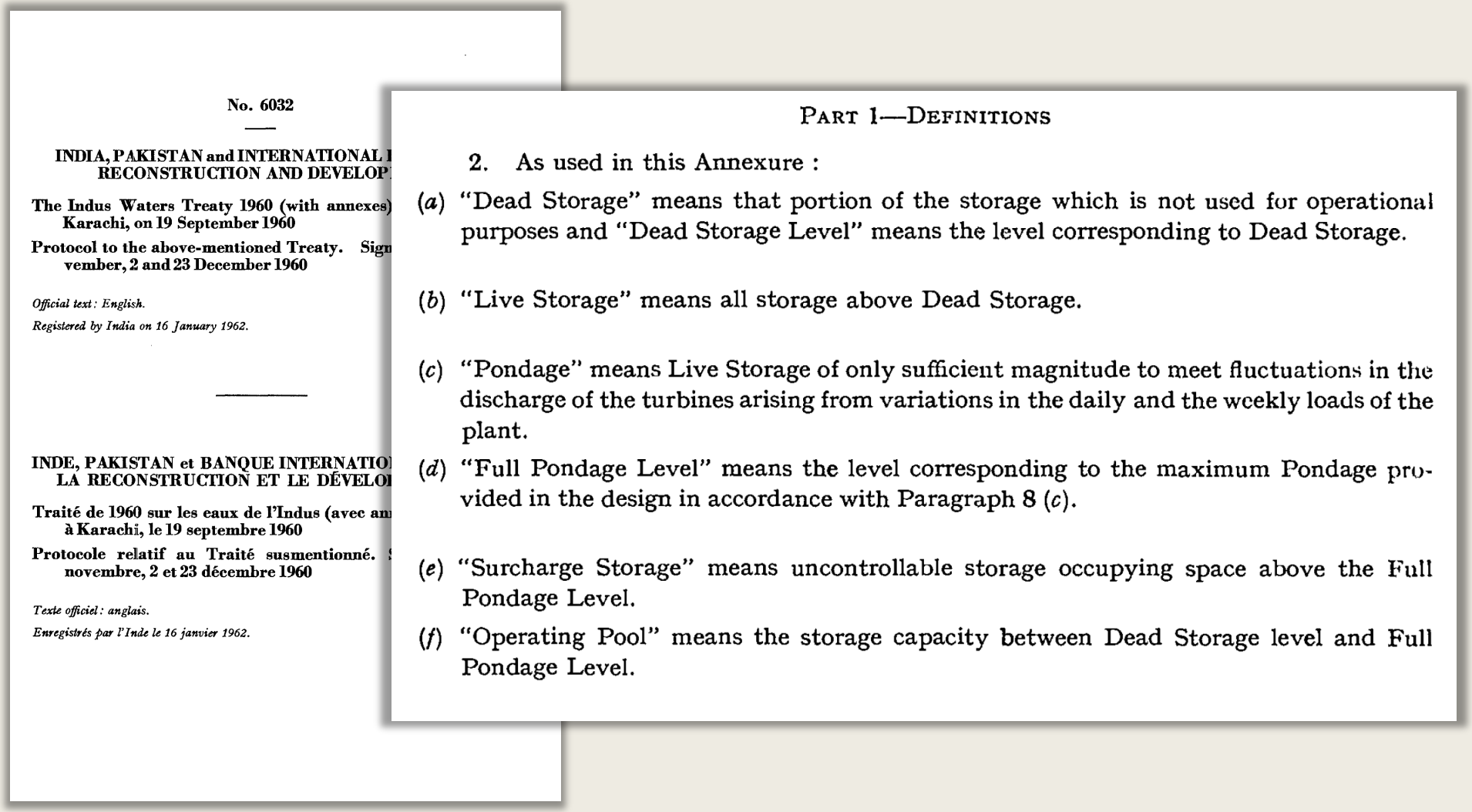
(*a*) The works themselves shall not be capable of raising artificially the water level in the Operating Pool above the Full Pondage Level specified in the design.

Annexure D, Paragraph 2



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INDE, PAKISTAN et BANQUE INTERNATIO
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Protocole relatif au Traité susmentionné.
novembre, 2 et 23 décembre 1960

Texte officiel: anglais.

Enregistrés par l'Inde le 16 janvier 1962.

PART 1—DEFINITIONS

2. As used in this Annexure :

(*a*) "Dead Storage" means that portion of the storage which is not used for operational purposes and "Dead Storage Level" means the level corresponding to Dead Storage.

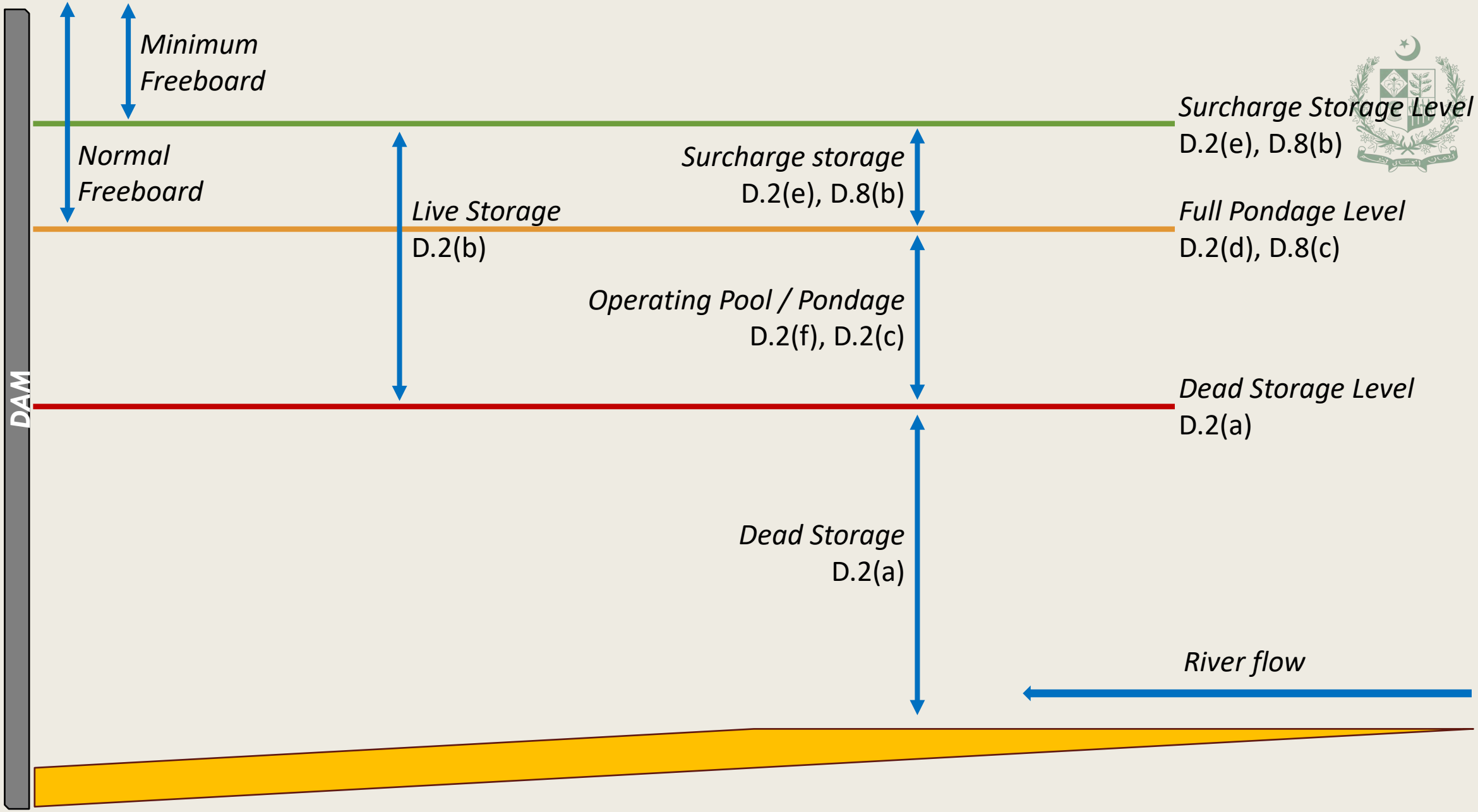
(*b*) "Live Storage" means all storage above Dead Storage.

(*c*) "Pondage" means Live Storage of only sufficient magnitude to meet fluctuations in the discharge of the turbines arising from variations in the daily and the weekly loads of the plant.

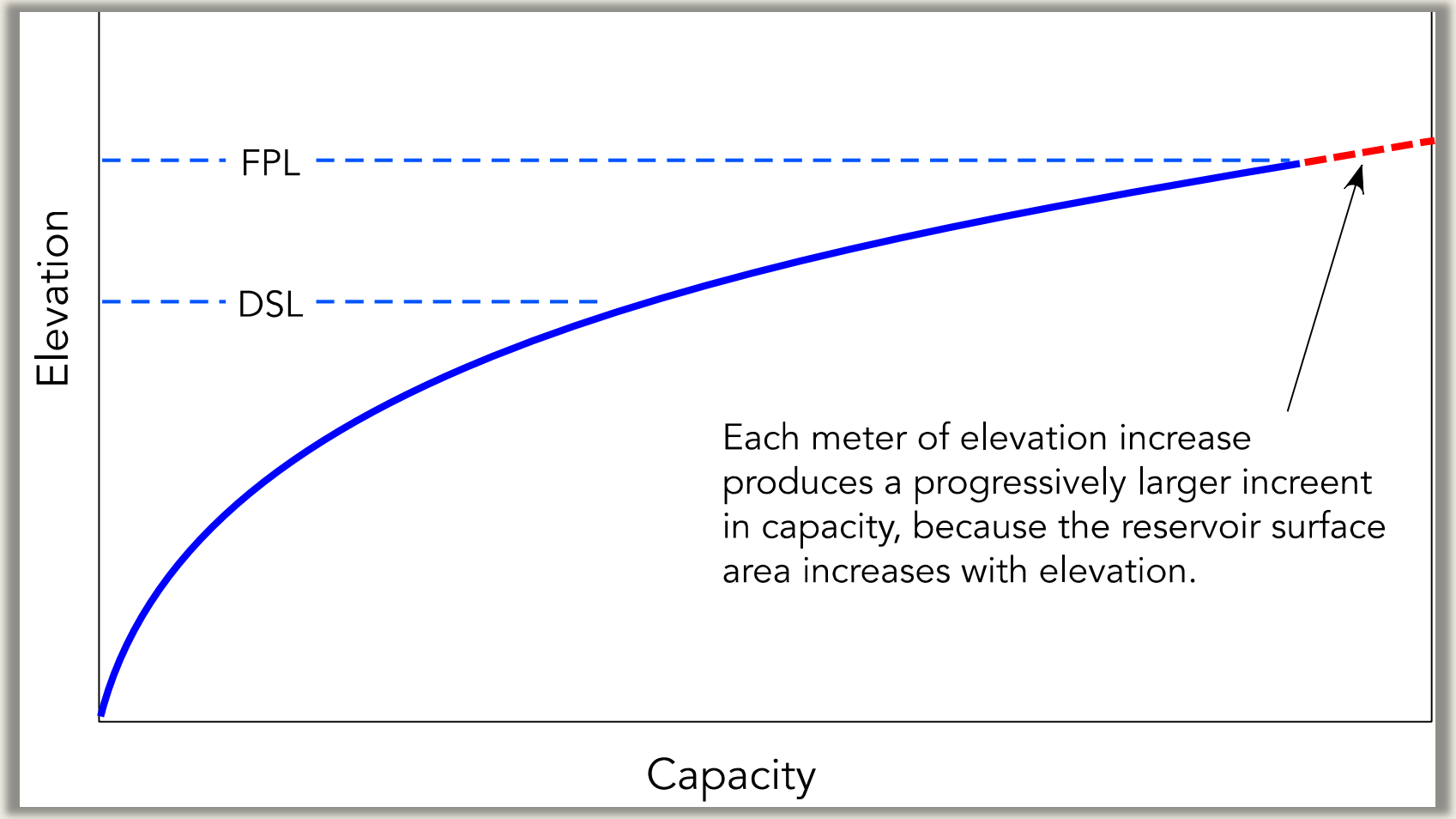
(*d*) "Full Pondage Level" means the level corresponding to the maximum Pondage provided in the design in accordance with Paragraph 8 (*c*).

(*e*) "Surcharge Storage" means uncontrollable storage occupying space above the Full Pondage Level.

(*f*) "Operating Pool" means the storage capacity between Dead Storage level and Full Pondage Level.


Minimum
Freeboard
Normal
Freeboard
DAM
Live Storage
D.2(b)
Surcharge storage
D.2(e), D.8(b)
Operating Pool / Pondage
D.2(f), D.2(c)
Dead Storage
D.2(a)
Surcharge Storage Level
D.2(e), D.8(b)
Full Pondage Level
D.2(d), D.8(c)
Dead Storage Level
D.2(a)
River flow

Elevation capacity curve



Article III(1), (2) and (4)

No. 6032

INDIA, PAKISTAN and INTERNATIONAL BANK F
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INDE, PAKISTAN et BANQUE INTERNATIONALE P
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Protocole relatif au Traité susmentionné. Signé l
novembre, 2 et 23 décembre 1960

Texte officiel: anglais.

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Article III

PROVISIONS REGARDING WESTERN RIVERS

(1) Pakistan shall receive for unrestricted use all those waters of the Western Rivers which India is under obligation to let flow under the provisions of Paragraph (2).

(2) India shall be under an obligation to let flow all the waters of the Western Rivers, and shall not permit any interference with these waters, except for the following uses, restricted (except as provided in item (*c*) (ii) of Paragraph 5 of Annexure C)[1] in the case of each of the rivers, The Indus, The Jhelum and The Chenab, to the drainage basin thereof :

(*a*) Domestic Use ;

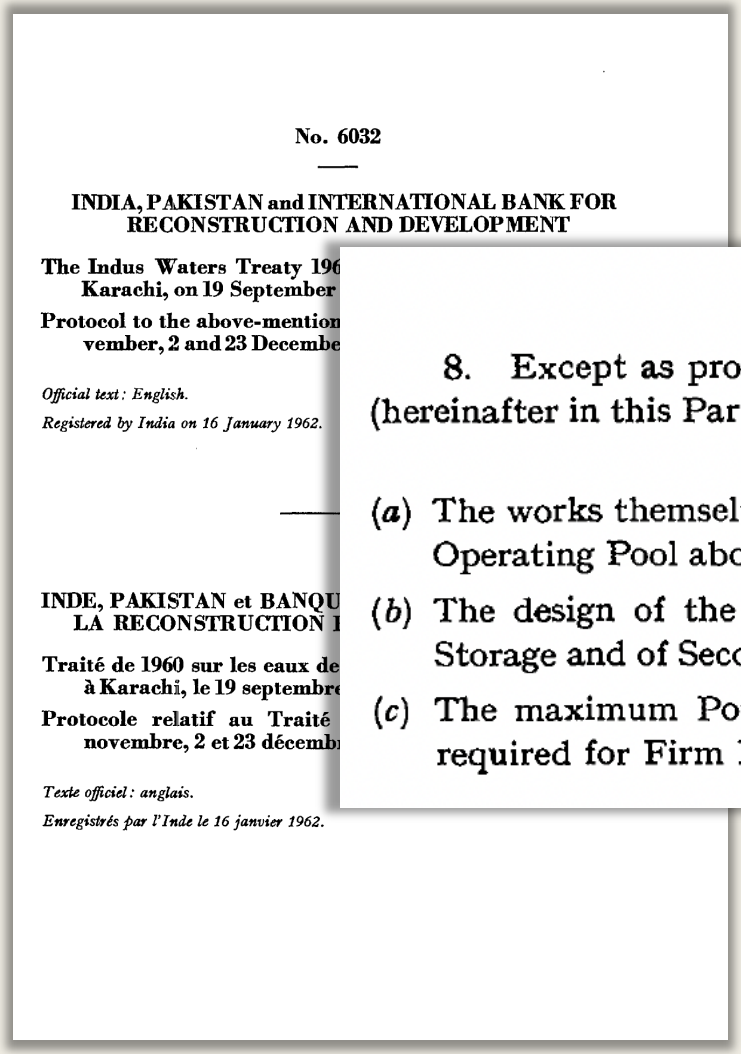
(*b*) Non-Consumptive Use ;

(*c*) Agricultural Use, as set out in Annexure C ; and

(*d*) Generation of hydro-electric power, as set out in Annexure D.[2]

(4) Except as provided in Annexures D and E,[1] India shall not store any water of, or construct any storage works on, the Western Rivers.

Annexure D, Paragraphs 8(a)–(c)



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INDIA, PAKISTAN and INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

The Indus Waters Treaty 196
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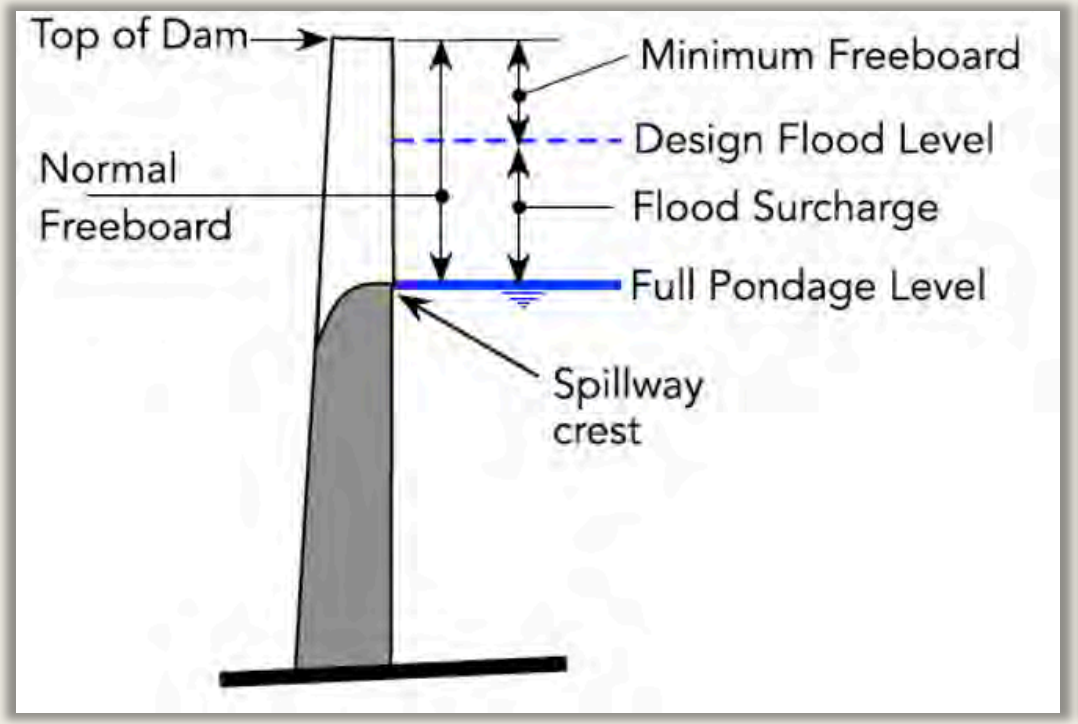
(*a*) The works themselves shall not be capable of raising artificially the water level in the Operating Pool above the Full Pondage Level specified in the design.

(*b*) The design of the works shall take due account of the requirements of Surcharge Storage and of Secondary Power.

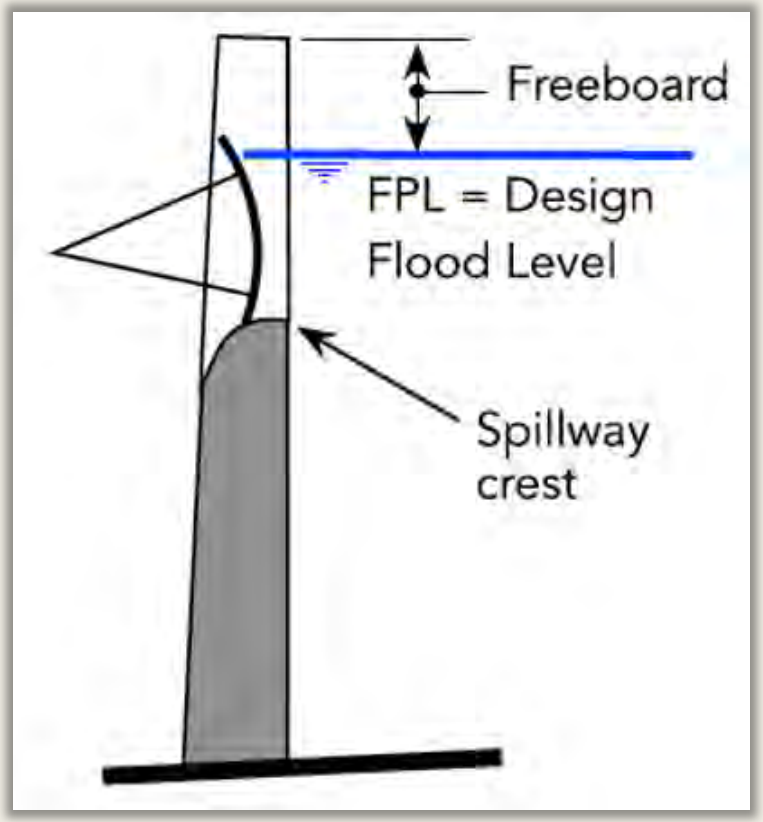
(*c*) The maximum Pondage in the Operating Pool shall not exceed twice the Pondage required for Firm Power.

Paragraph 8(a) for an ungated spillway



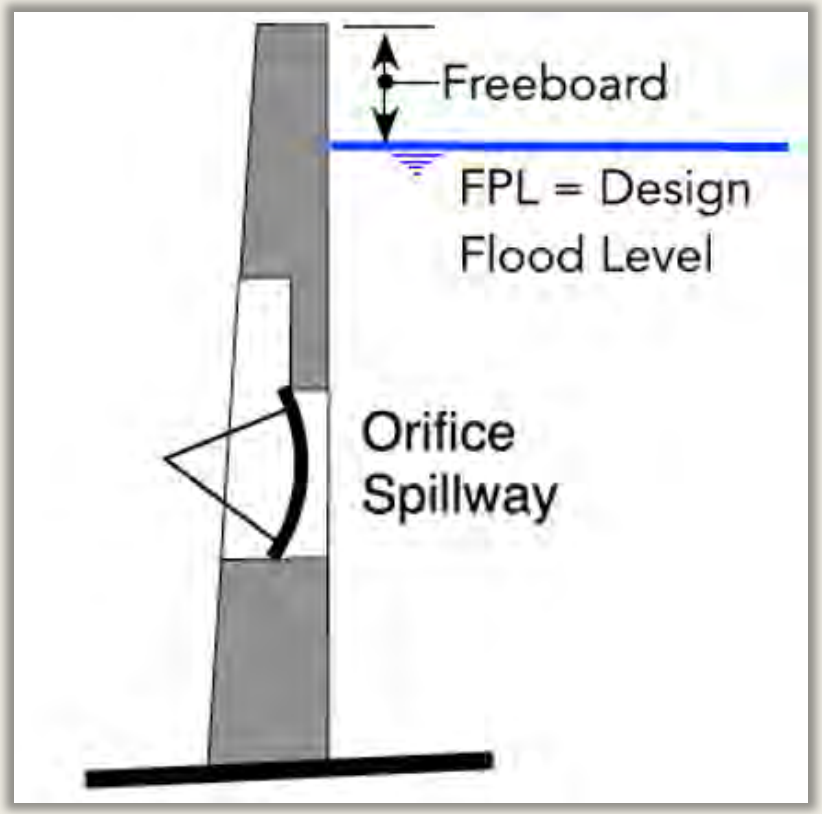
Memorial, fig. 4.26(a)
P-0610

Paragraph 8(a) for a surface gated spillway



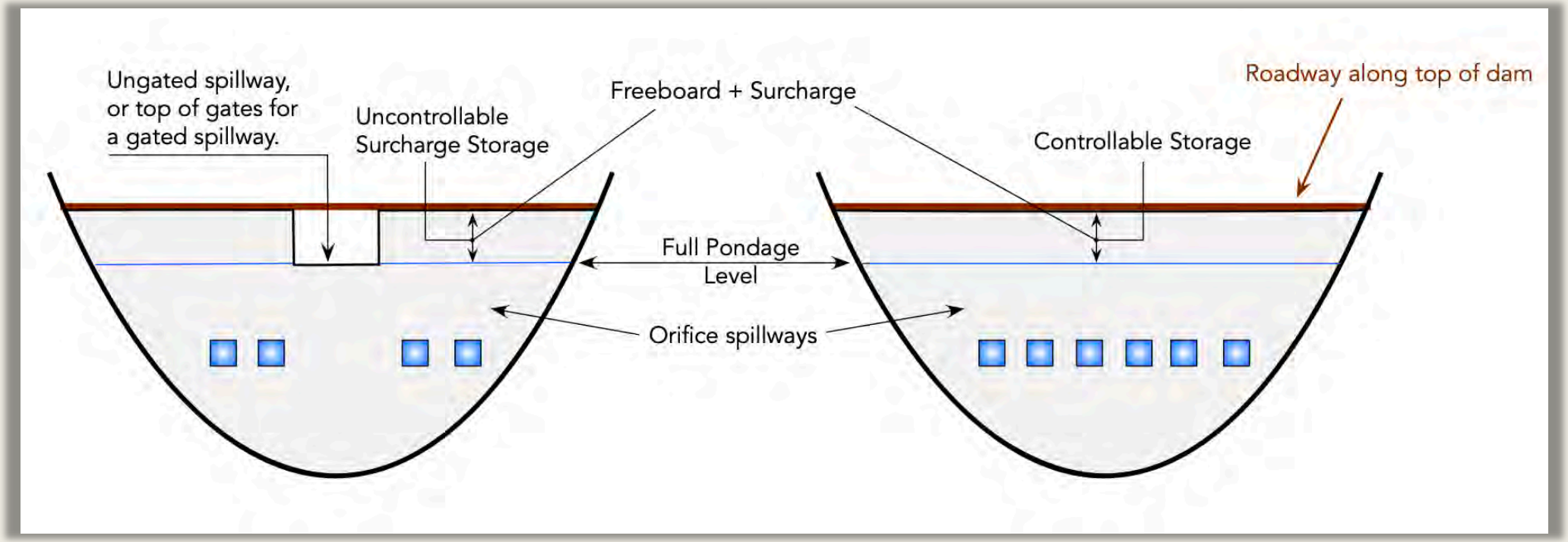
Memorial, fig. 4.26(b)
Site Visit Presentation 5, slide 16

Paragraph 8(a) for an orifice spillway (I)



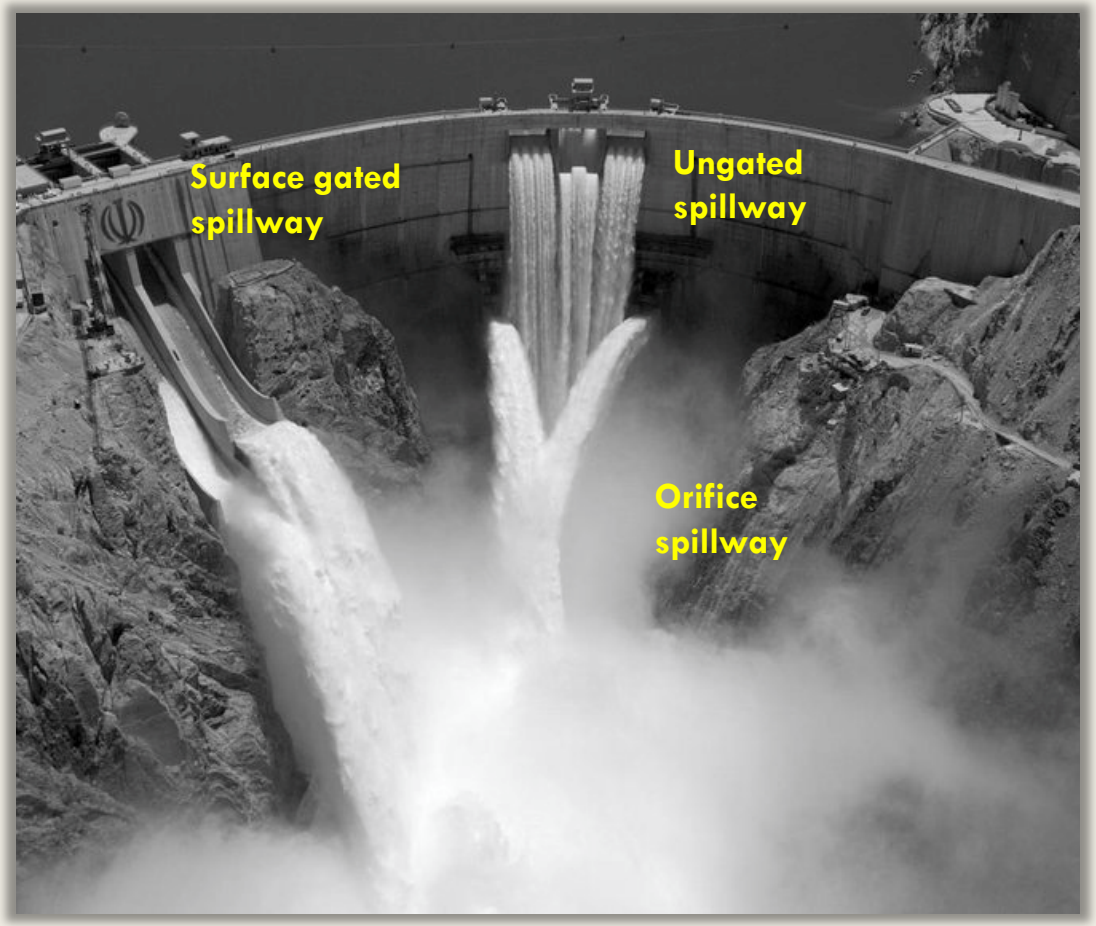
Memorial, fig. 4.26(c)
Site Visit Presentation 5, slide 11

Paragraph 8(a) for an orifice spillway (II)



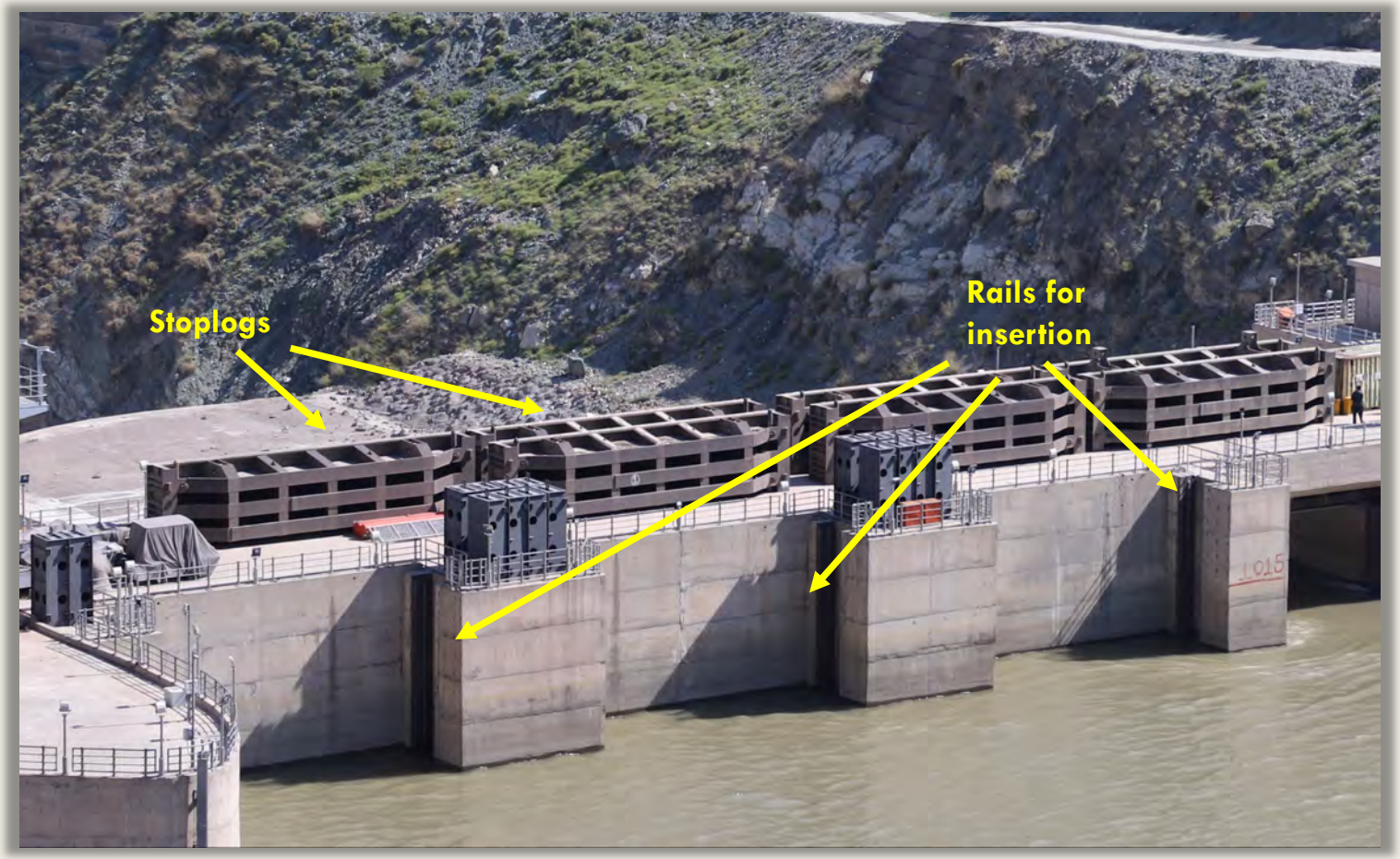
Memorial, fig. 12.3

Paragraph 8(a) for a combination spillway design



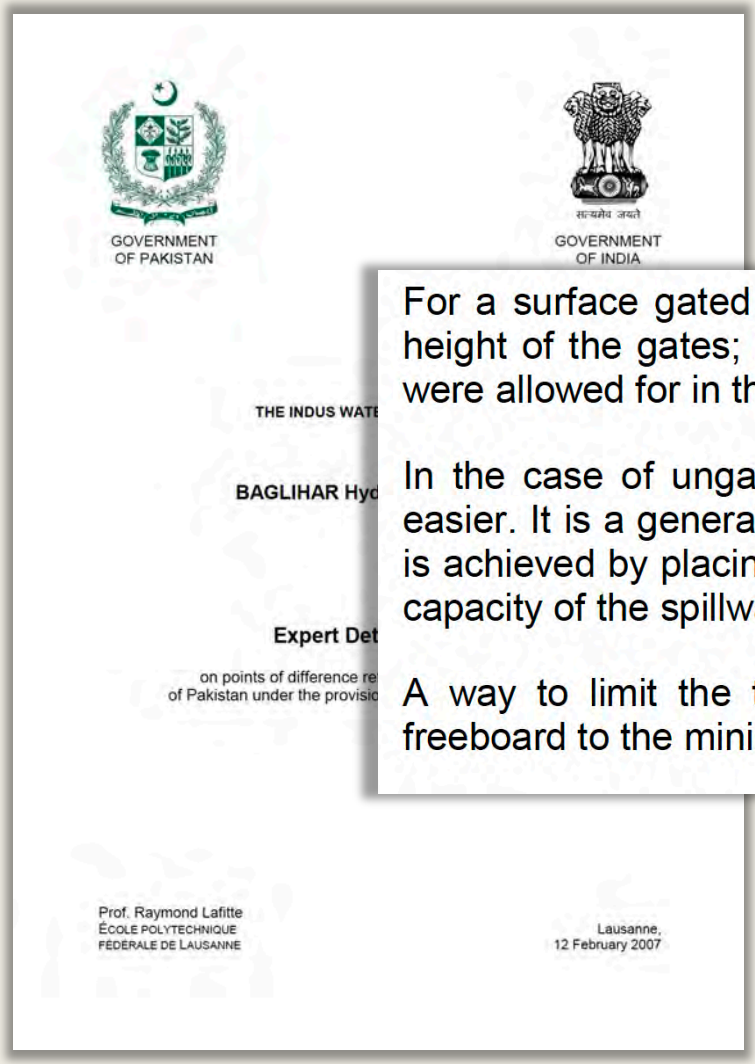
Memorial, fig. 12.4
P-0609

Paragraph 8(a) and freeboard regulation



- **Stoplogs** may be used to block off spillways for maintenance.
- Once blocked off, spillway outlets will be rendered **watertight.**
- Same effect may be achieved with **temporary structures** added after construction, e.g. **fuse gates or flashboards.**

Freeboard regulation in *Baglihar* (I)


GOVERNMENT
OF PAKISTAN

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of Pakistan under the provisio

Prof. Raymond Lafitte
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Lausanne,
12 February 2007

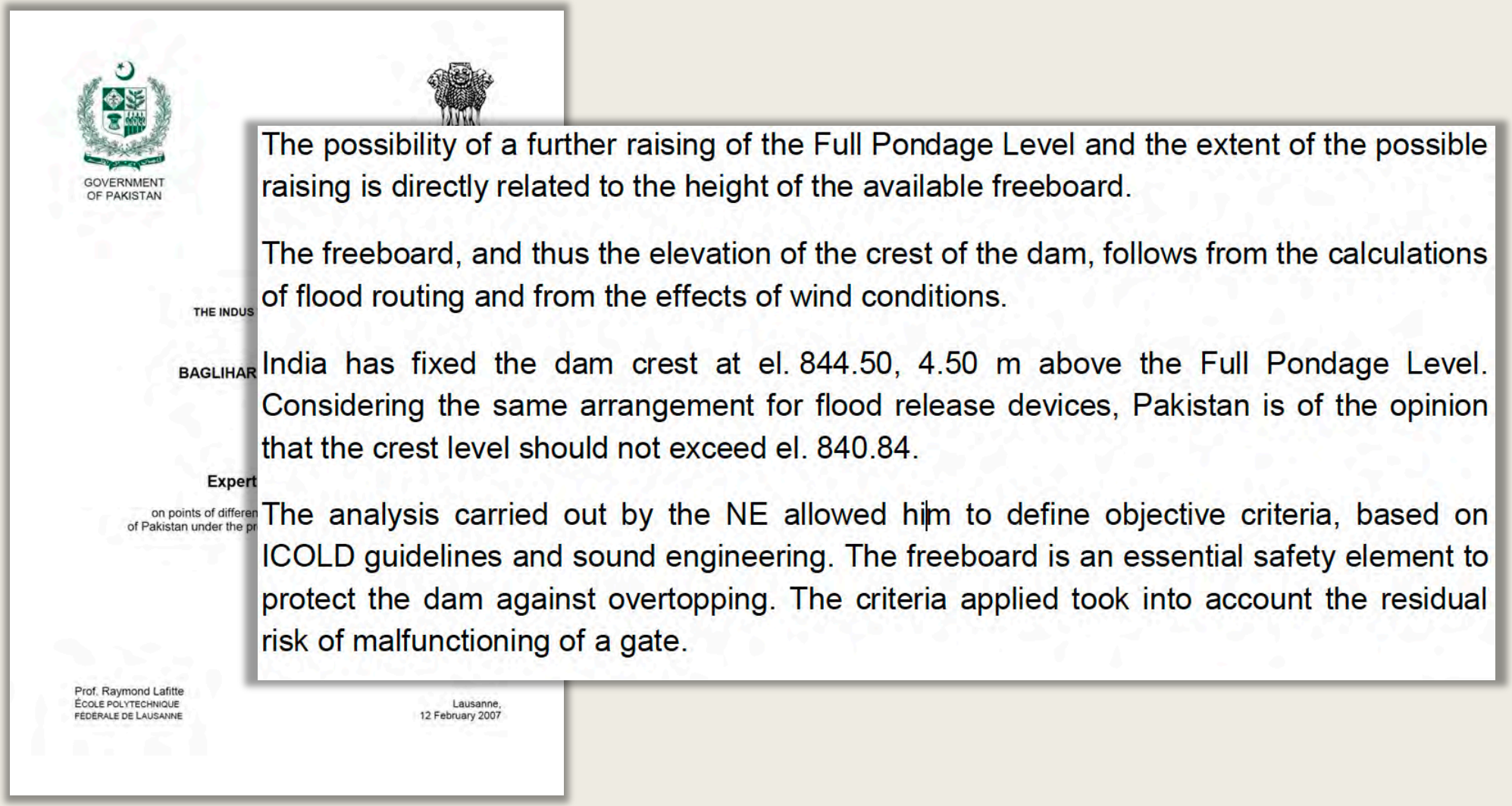
For a surface gated spillway, the artificial raising of the level is possible by increasing the height of the gates; however, this is not technically easy unless measures for this purpose were allowed for in the initial design.

In the case of ungated surface spillways, the artificial raising of the full pondage level is easier. It is a generally accepted way of improving the performance of an existing dam. This is achieved by placing gates on the crest (possibly fusegates) so as not to affect the spilling capacity of the spillway.

A way to limit the technical possibility of raising the Full Pondage Level is to limit the freeboard to the minimum required.

PLA-0002,
§5.8.1

Freeboard regulation in *Baglihar* (II)



GOVERNMENT
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Expert

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The possibility of a further raising of the Full Pondage Level and the extent of the possible raising is directly related to the height of the available freeboard.

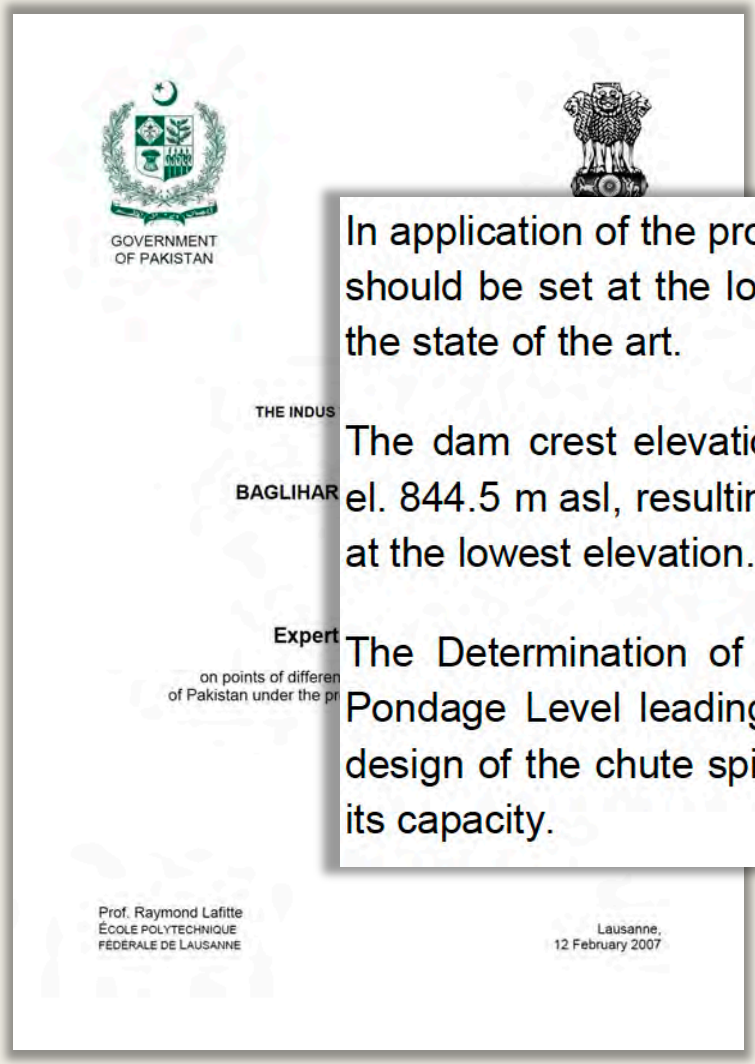
The freeboard, and thus the elevation of the crest of the dam, follows from the calculations of flood routing and from the effects of wind conditions.

India has fixed the dam crest at el. 844.50, 4.50 m above the Full Pondage Level. Considering the same arrangement for flood release devices, Pakistan is of the opinion that the crest level should not exceed el. 840.84.

The analysis carried out by the NE allowed him to define objective criteria, based on ICOLD guidelines and sound engineering. The freeboard is an essential safety element to protect the dam against overtopping. The criteria applied took into account the residual risk of malfunctioning of a gate.

PLA-0002,
§5.8.9

Freeboard regulation in *Baglihar* (III)



GOVERNMENT
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THE INDUS

BAGLIHAR

Expert

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12 February 2007

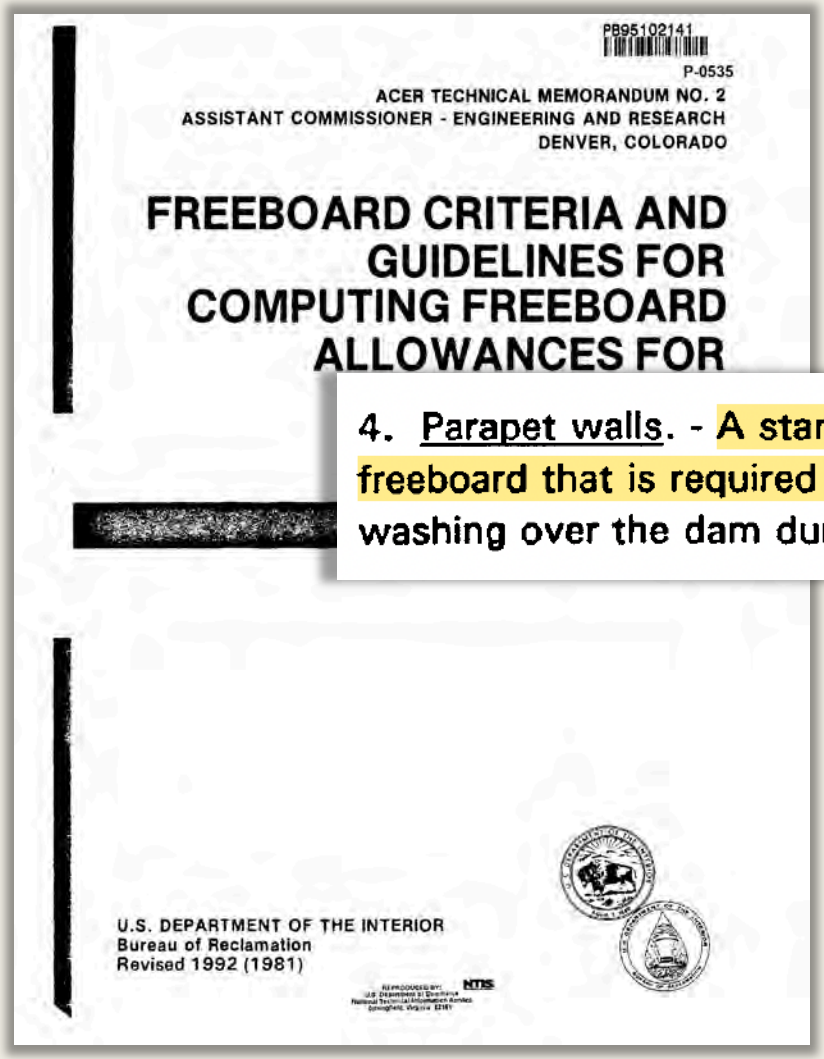
In application of the provisions of the Treaty, the NE considers that the dam crest elevation should be set at the lowest elevation compatible with a sound and safe design based on the state of the art.

The dam crest elevation of the Baglihar dam, fixed in the design submitted by India at el. 844.5 m asl, resulting from a freeboard above the Full Pondage Level of 4.50 m is not at the lowest elevation.

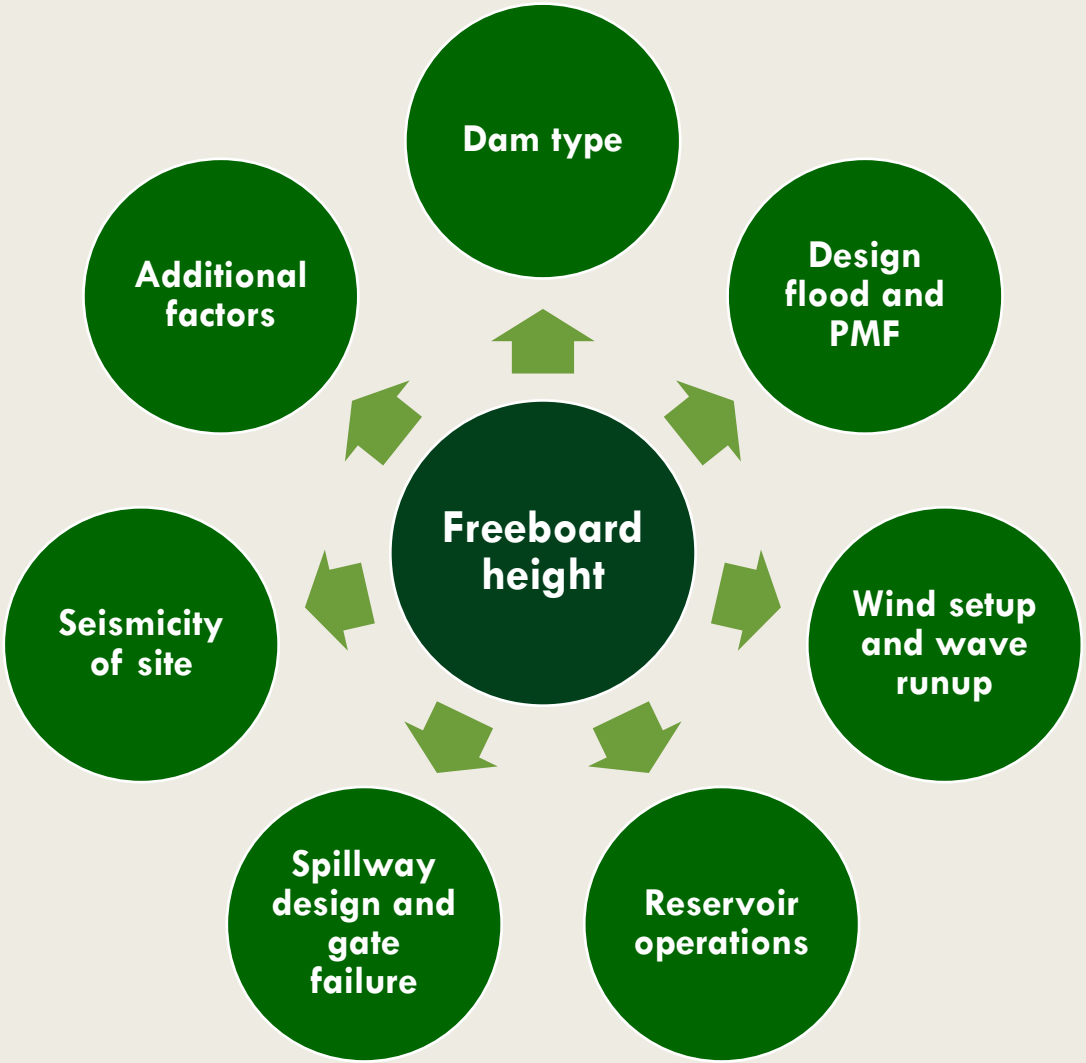
The Determination of the NE is that the freeboard should be of 3 m above the Full Pondage Level leading to a dam crest elevation at 843.0 m asl. This is possible if the design of the chute spillway is optimised by minor shape adjustments in order to increase its capacity.

PLA-0002,
§6.4 (¶ 2)

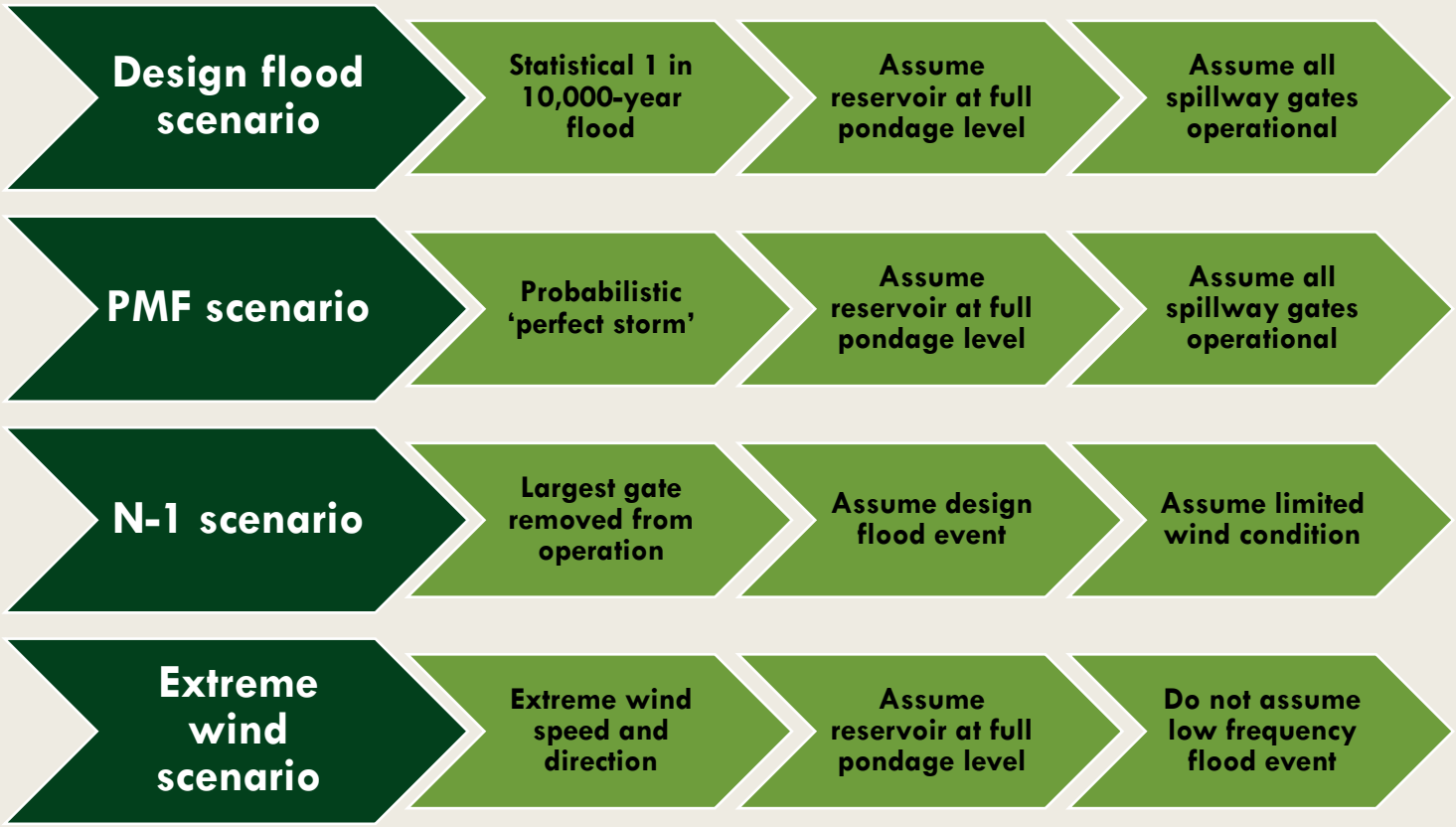
International standards for fixing freeboard height



4. Parapet walls. - A standard 3.5-foot (1.1-m) high parapet wall provides all of the freeboard that is required for concrete dams. This wall is intended to keep waves from washing over the dam during high reservoir water levels.

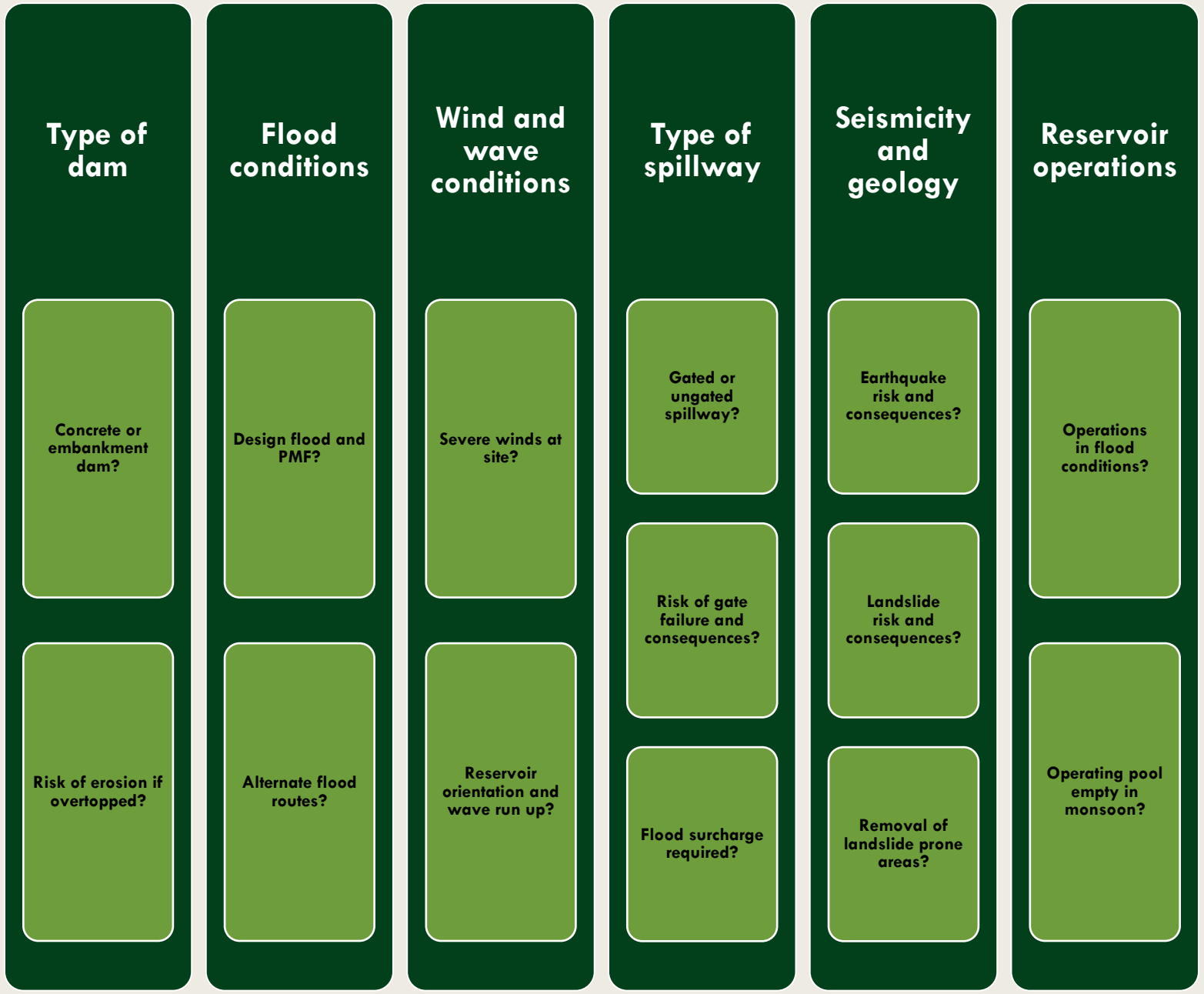


US Bureau of Reclamation freeboard considerations



Fixing freeboard height in *Baglihar*

PLA-0002, §5.8.4

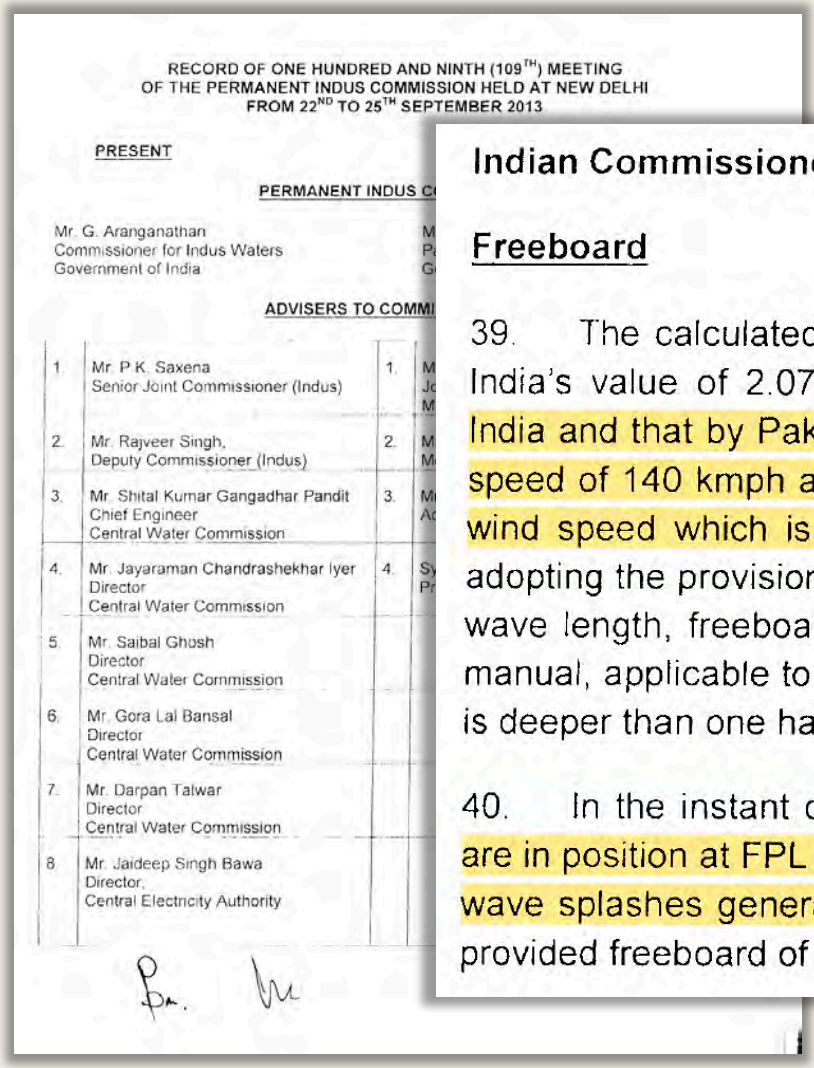


Potential safety criteria for freeboard height

Part IV

India's case on freeboard

India's case in the Permanent Indus Commission (I)



RECORD OF ONE HUNDRED AND NINTH (109TH) MEETING
OF THE PERMANENT INDUS COMMISSION HELD AT NEW DELHI
FROM 22ND TO 25TH SEPTEMBER 2013

PRESENT

PERMANENT INDUS C

Mr. G. Aranganathan
Commissioner for Indus Waters
Government of India

ADVISERS TO COMMI

1.	Mr. P.K. Saxena Senior Joint Commissioner (Indus)	1.	M Jo M
2.	Mr. Rajveer Singh, Deputy Commissioner (Indus)	2.	M M
3.	Mr. Shital Kumar Gangadhar Pandit Chief Engineer Central Water Commission	3.	M Ac
4.	Mr. Jayaraman Chandrashekhar Iyer Director Central Water Commission	4.	Sy Pr
5.	Mr. Saibal Ghosh Director Central Water Commission		
6.	Mr. Gora Lal Bansal Director Central Water Commission		
7.	Mr. Darpan Talwar Director Central Water Commission		
8.	Mr. Jaideep Singh Bawa Director, Central Electricity Authority		

Indian Commissioner's View

Freeboard

39. The calculated value of Free Board by Pakistan is 1.1m as against that of India's value of 2.07m. The difference in the values of freeboard computed by India and that by Pakistan seems to arise mainly due to Pakistan presuming wind speed of 140 kmph as a short gust and India adopting 140 kmph as basic design wind speed which is provided in Indian code of practice. Indian side also cited adopting the provisions of ACER manual which requires that in case of deep water wave length, freeboard has to be computed as per provisions of Para 2(f) of the manual, applicable to relatively deep reservoirs. In the instant case, depth of water is deeper than one half of the wave length.

40. In the instant case, FPL and MWL are identical. As such, when the gates are in position at FPL the spillway bridge beams have to be adequately clear of the wave splashes generated due to wind. As such, from practical consideration, the provided freeboard of 2.0 m is bare minimum.

P-0083,
¶¶ 39–40

India's case in the Permanent Indus Commission (II)

RECORD OF ONE HUNDRED AND TENTH (110TH) MEETING
OF THE PERMANENT INDUS COMMISSION HELD AT LAHORE
FROM 23RD TO 27TH AUGUST 2014

PRESENT

PERMANENT IND

Mr. K. Vohra
Indian Commissioner for Indus Waters
Government of India

ADVISERS TO CO

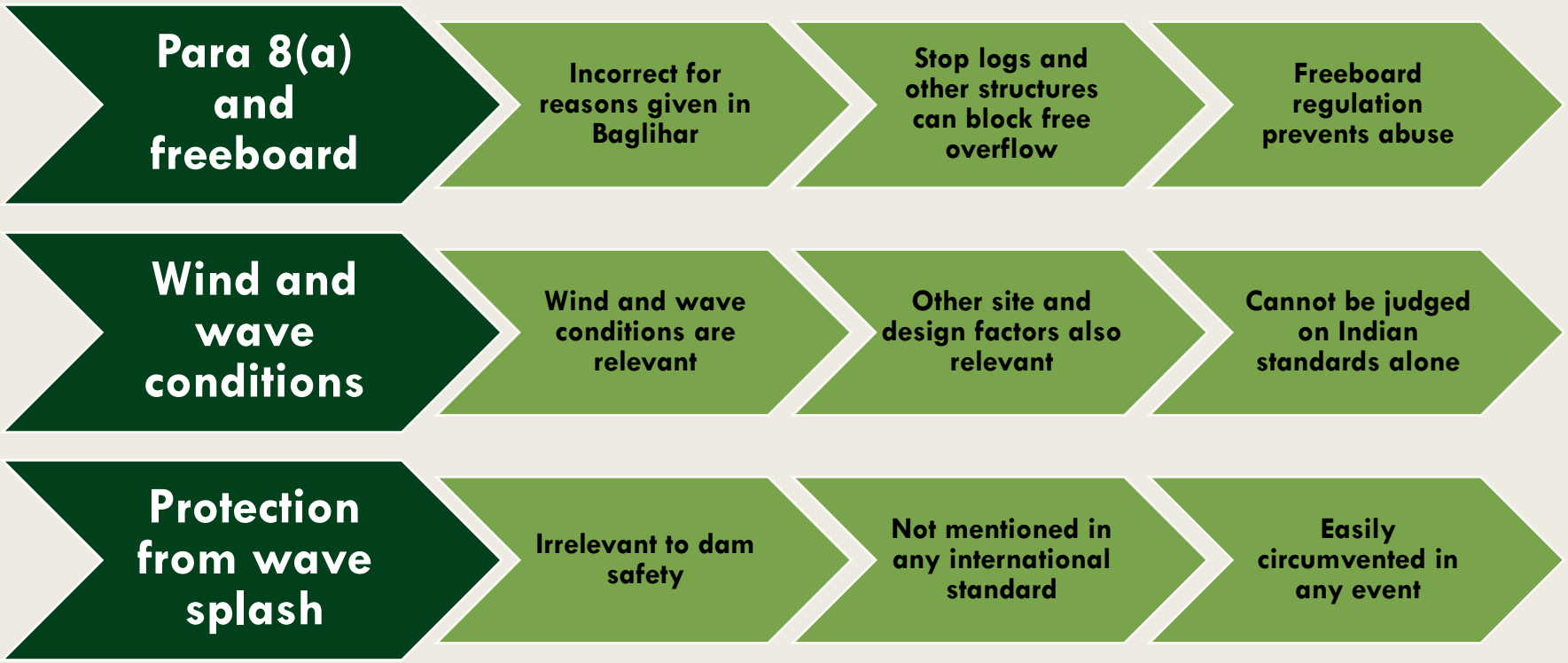
1. Mr. P.K. Saxena
Senior Joint Commissioner (Indus)
2. Dr. V.D. Sharma
Director
Ministry of External Affairs
3. Mr. Saibal Ghosh
Director
Central Water Commission
4. Mr. Gora Lal Bansal
Director
Central Water Commission
5. Mr. Jaideep Singh Bawa
Director
Central Electricity Authority
6. Mr. Rajveer Singh,
Deputy Commissioner (Indus)
7. Mr. Keshav Deshmukh
Chief Engineer, NHPC
8. Mr. Rajeev Baboota
Chief Engineer, NHPC
9. Mr. Vishal Saini
Chief Engineer, NHPC

1. Mr. Riaz Ahmed
Deputy Commissioner for Indus Waters
8. Mr. Ross Masud
Legal Consultant

26. Regarding freeboard provision, ICIW mentioned that with crest gate top at Full Pond Level (FPL), there is no possibility to raise water level artificially. Further, Indian side mentioned that keeping the bearings of the bridge below the FPL is neither advisable nor an adopted practice throughout the world. There is no scope for reduction of depth of girder either which has been kept as bare minimum required from structural point of view to keep the deflections within permissible limit. The freeboard provided by India is bare minimum from practical point of view as the girder depth under spillway-bridge in the instant case cannot be reduced below 1.70 m from structural considerations. Moreover, the arrangement does not provide capability to artificially raise the water level. There cannot be any credible argument for keeping the bearings submerged in water by keeping them below FPL. It is a worldwide practice to provide freeboard of about 2 m wherever crest gated spillwa are provided.

27. PCIW requested ICIW for the details/drawings of the girder for examination. Indian side mentioned that details have already been explained to Pakistan side.

P-0024,
¶¶ 26–27



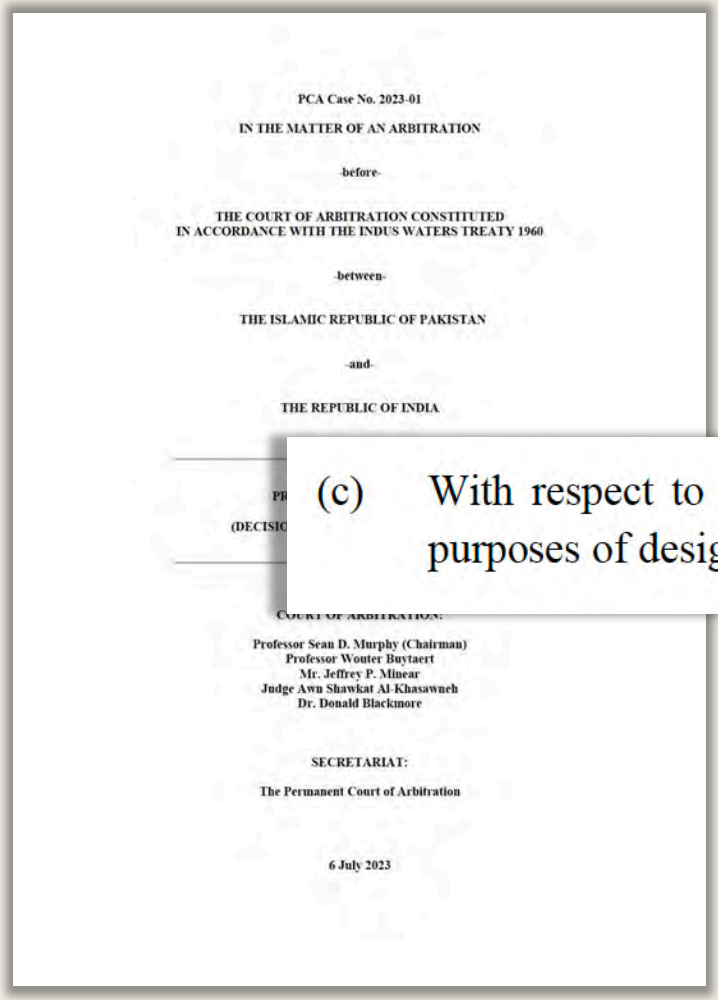
India's position is misguided

P-0024, ¶¶ 26–27

Part V

Answering the Court's question on freeboard

The Court's freeboard question reconsidered



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

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

SECRETARIAT:

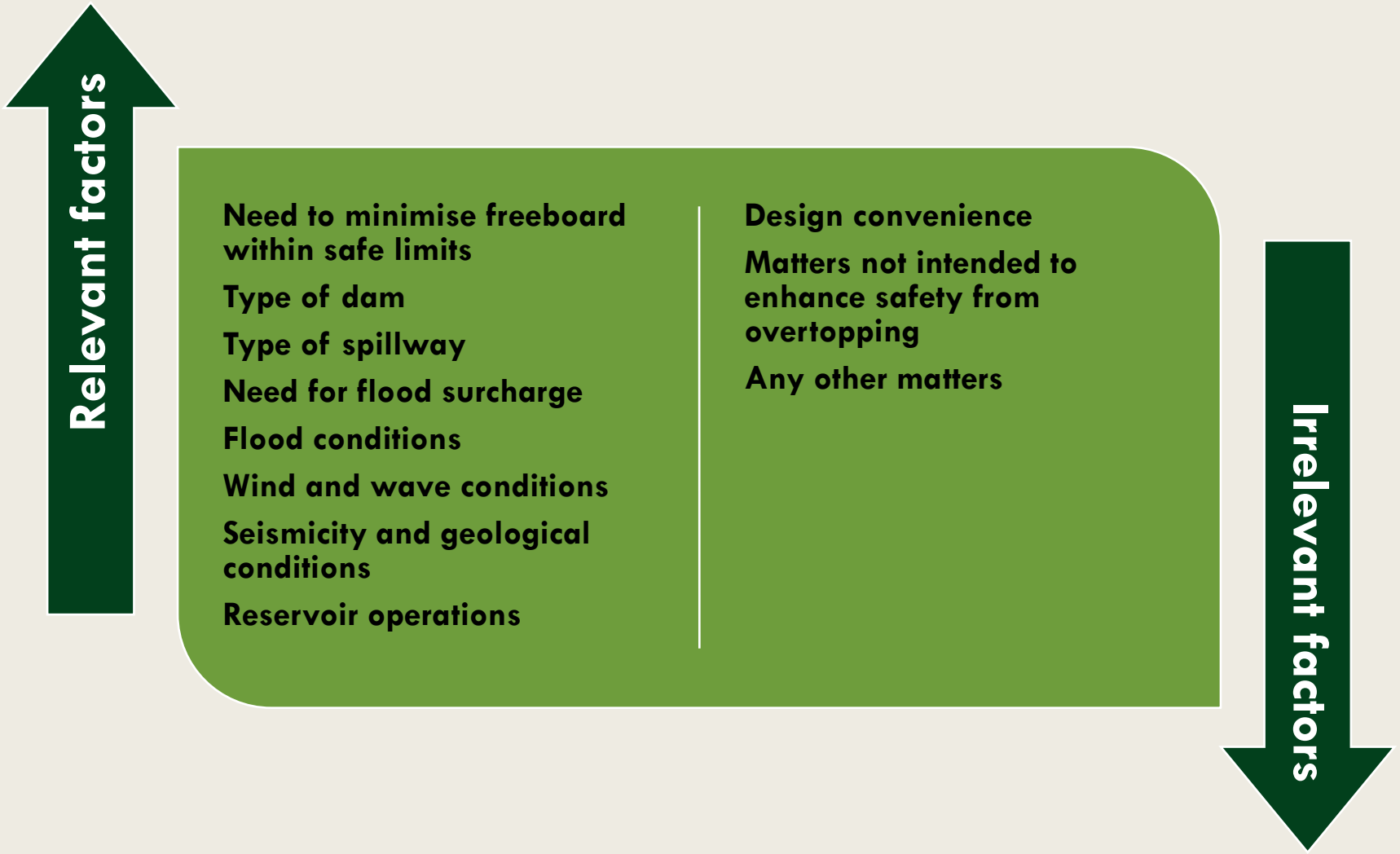
The Permanent Court of Arbitration

6 July 2023

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

PO6, ¶ 35(c)

Relevant and irrelevant factors for freeboard height




ایمان اتحاد نظم