



ENGINEERING ANALYSIS (Second Round)

Peter Rae

*Indus Waters Western Rivers Arbitration
(Pakistan v. India)
PCA Case No. 2023-01*

Hearing for the Second Phase on the Merits

3 February 2026



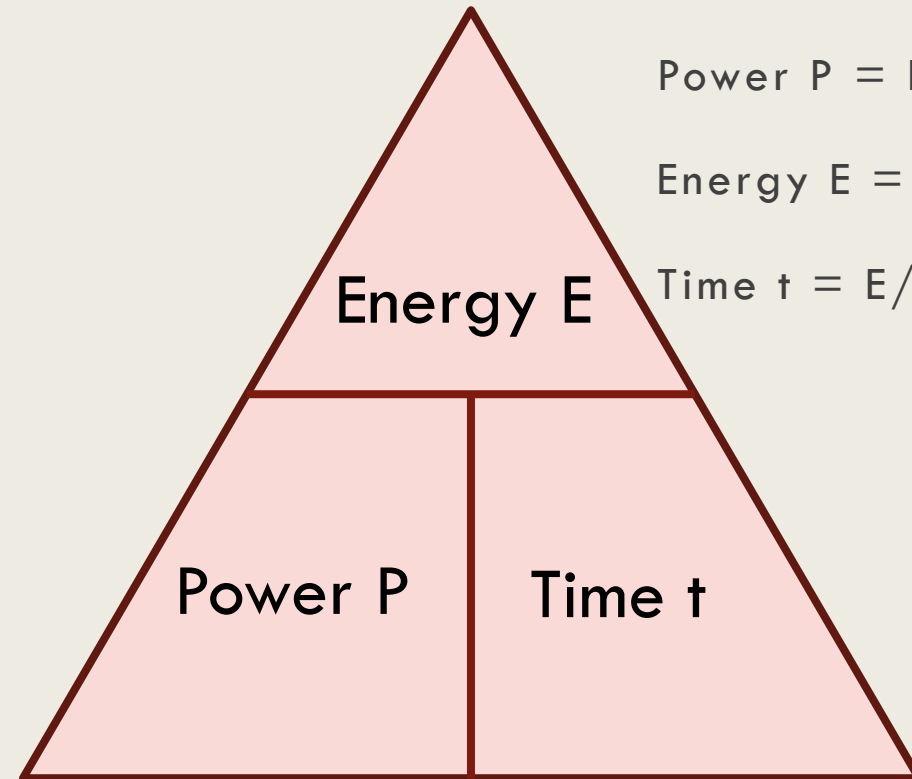
Summary of Inputs

1. Minimum Mean Discharge (m^3/s)
2. Plant characteristics
 - Capacity (MW)
 - Rated Discharge (m^3/s)
 - Minimum Discharge (m^3/s)
 - Head, efficiency, etc.
 - Eflow
3. Load of the Plant



Summary of Calculation

$$V_p = \left(24(Q - Q_e) - \frac{(24)(Q - Q_e)^2}{Q_p} \right) \times 0.0036$$



$$\text{Power } P = E/t$$

$$\text{Energy } E = P \times t$$

$$\text{Time } t = E/P$$

Calculation Steps

Load of the Plant based on the actual load of the power system

Adjust for Firm Power and the Load of the Plant gives the daily energy within the week

Peaking duration from load of the plant. Daily range not less than four to six hours but up to the maximum limit with the turbine minimum discharge.

Peaking capacity be limited by the need for maintenance and a rational plant loading during the dry season.

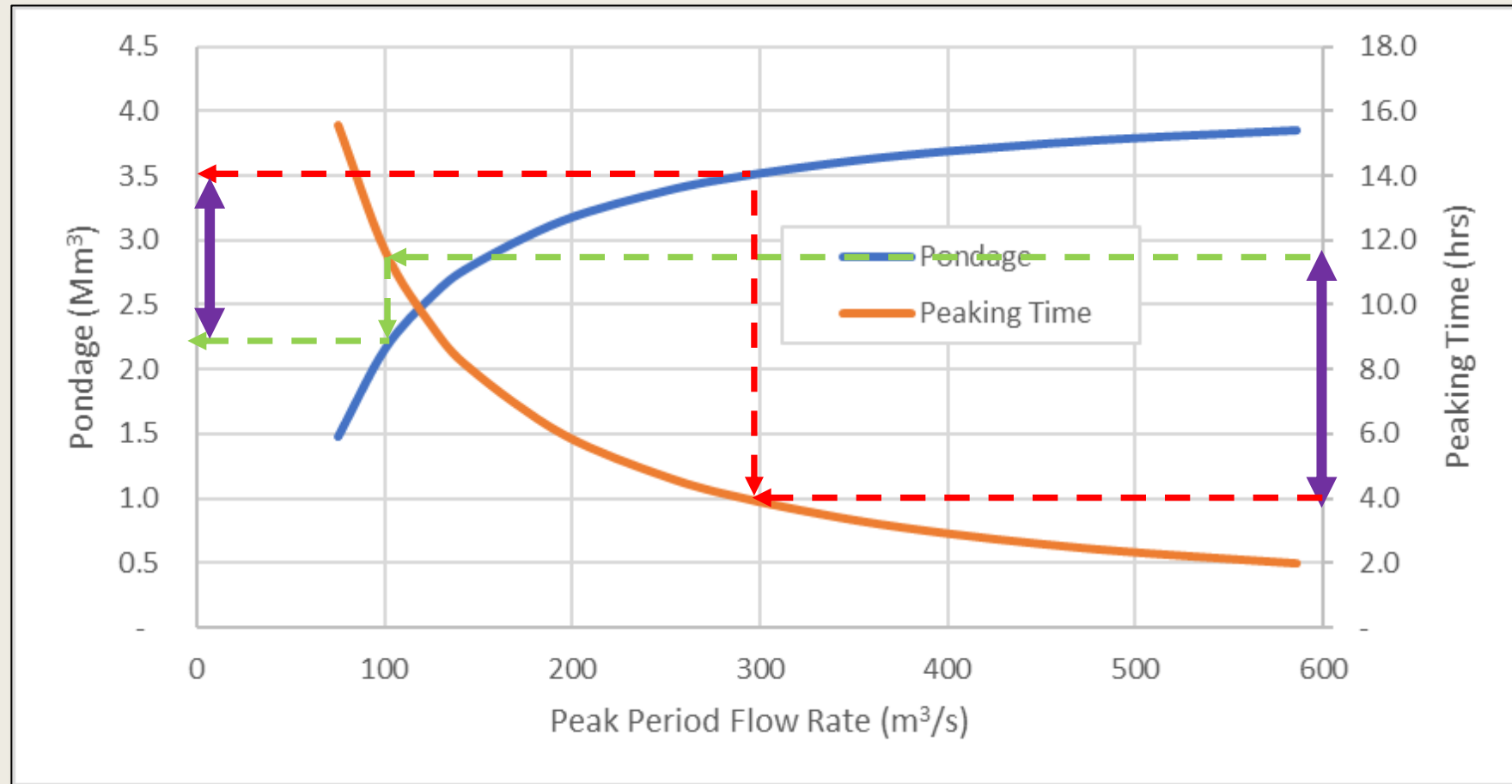
Determine governing criterion for Capacity = Energy/time or Time = Energy/Capacity

Compute hourly load/discharge

Compute Pondage



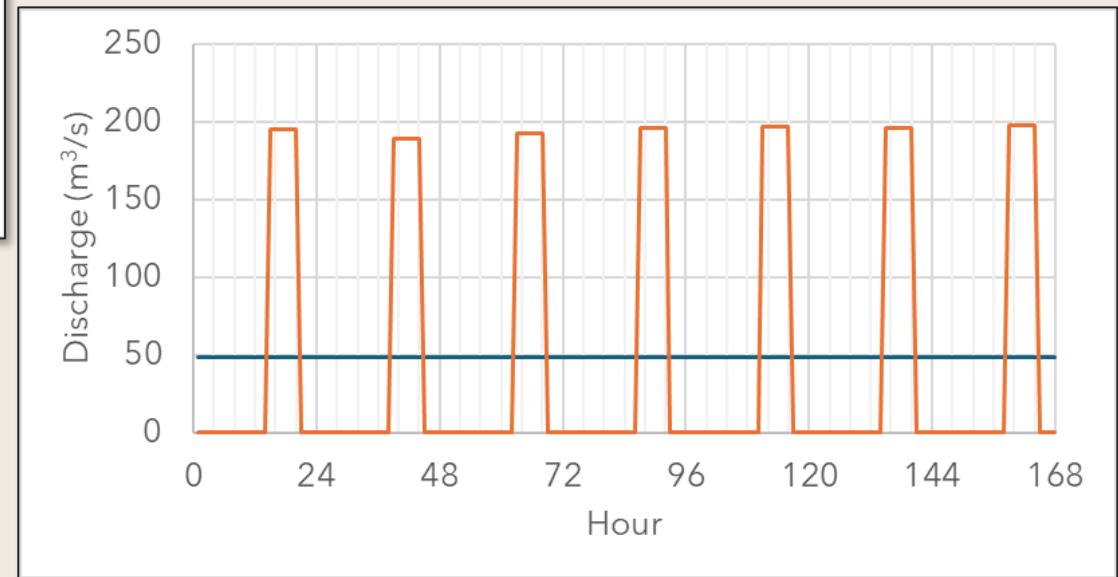
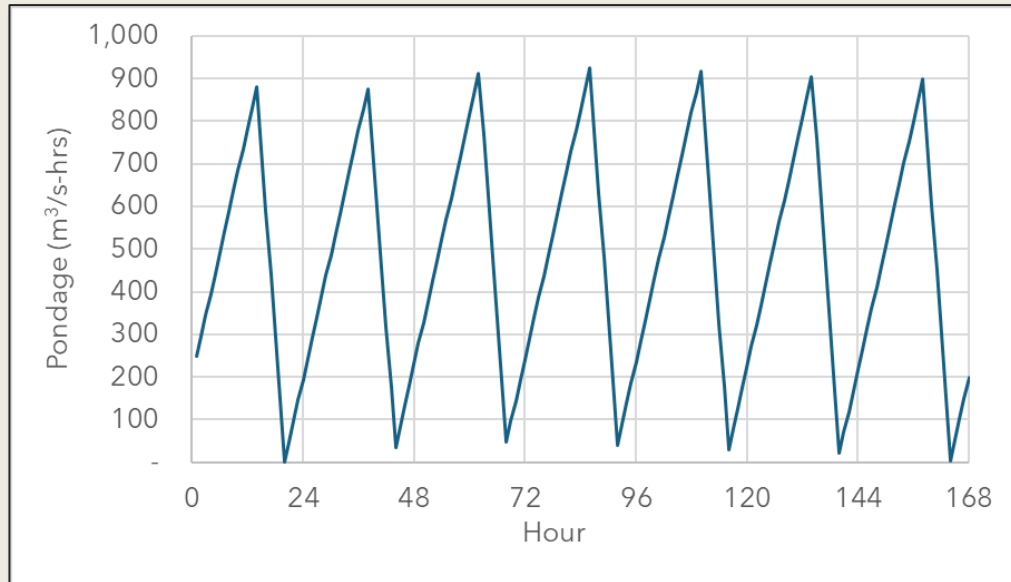
Daily Pondage Output



Second Phase Memorial, Appendix D, Figure 9



Weekly Pondage





Baglihar Example

Rated Discharge Capacity: $860 \text{ m}^3/\text{s}$

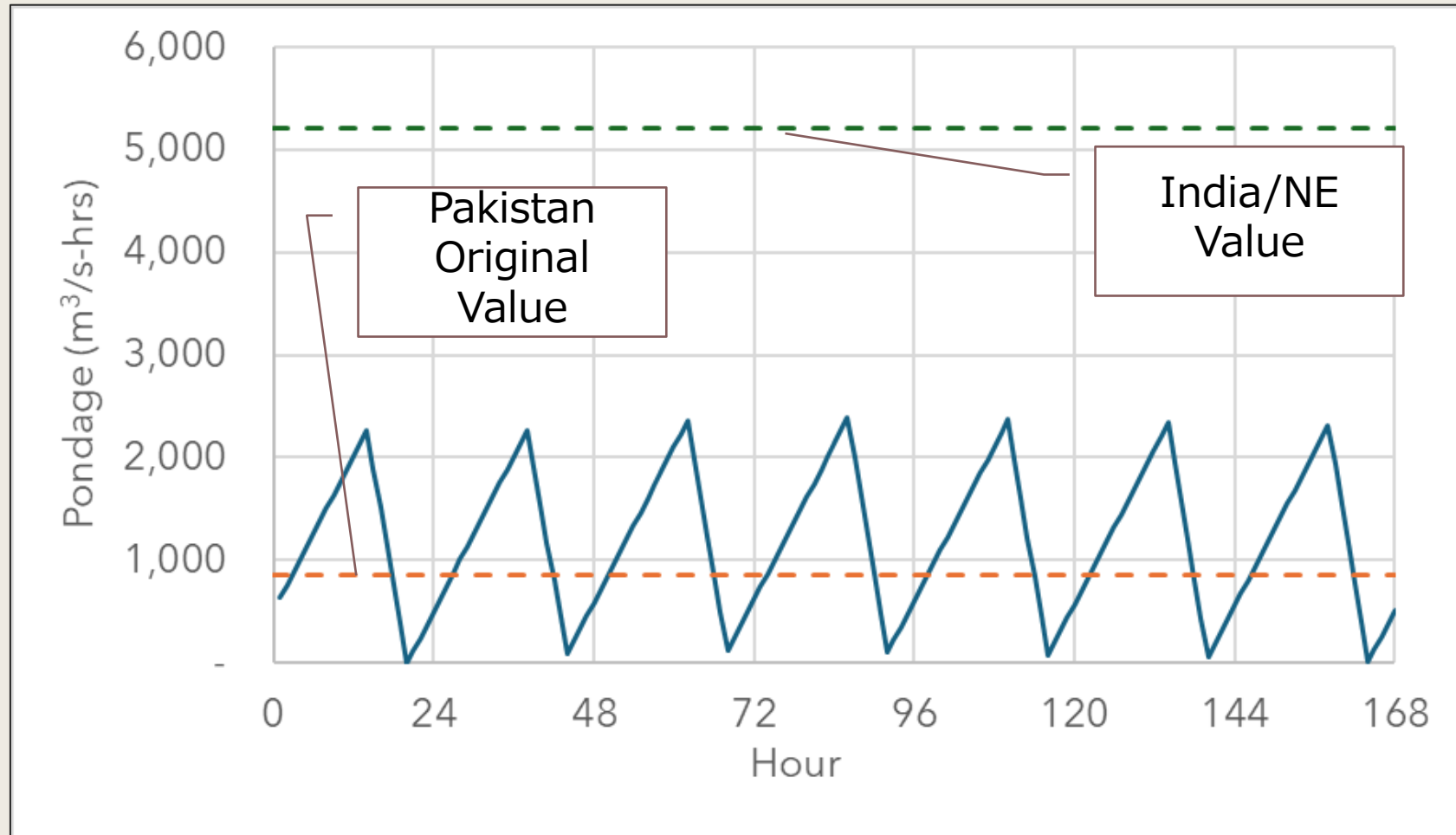
Power (Phase 1 and 2): 900 MW

MMD: $125.68 \text{ m}^3/\text{s}$

Turbines: 6

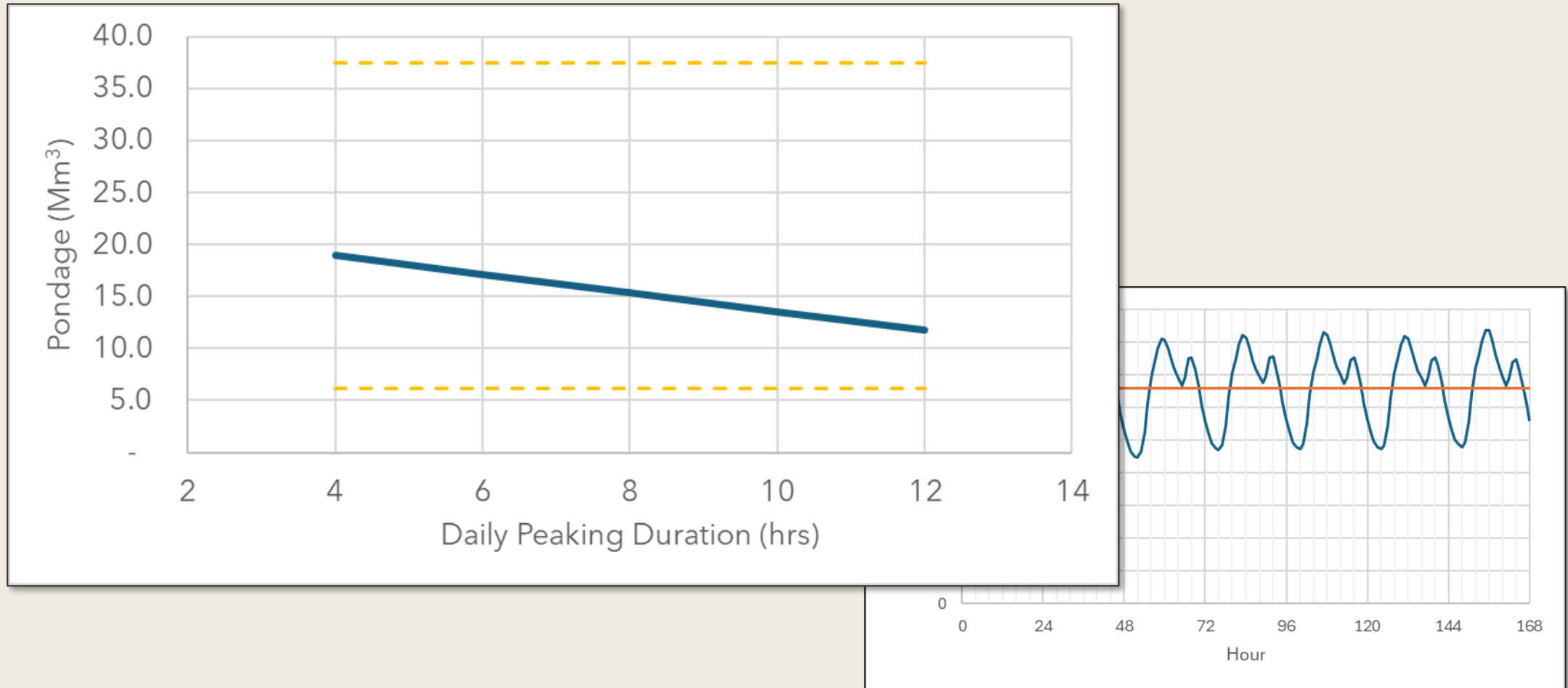


Pondage

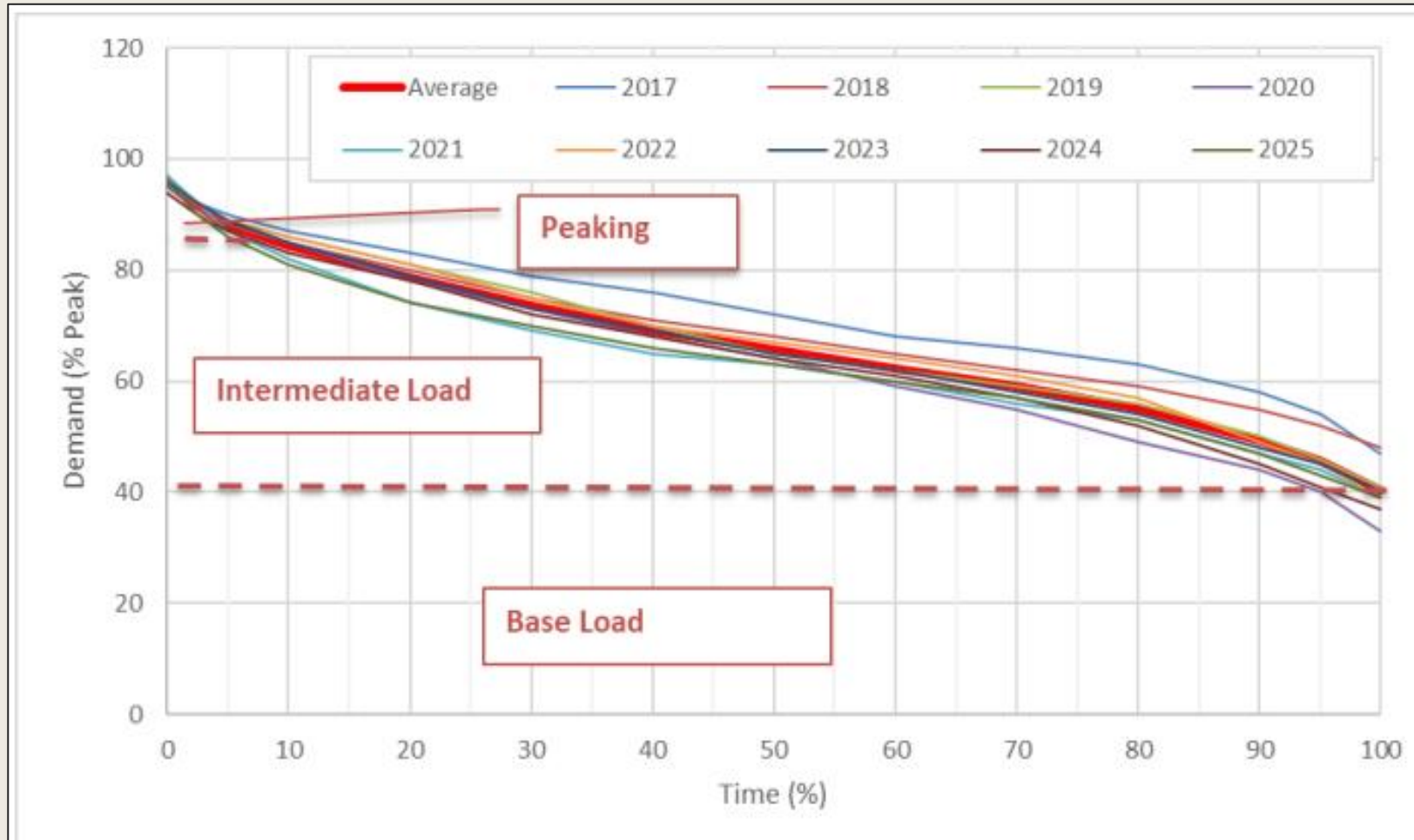




Pondage vs Generating Duration



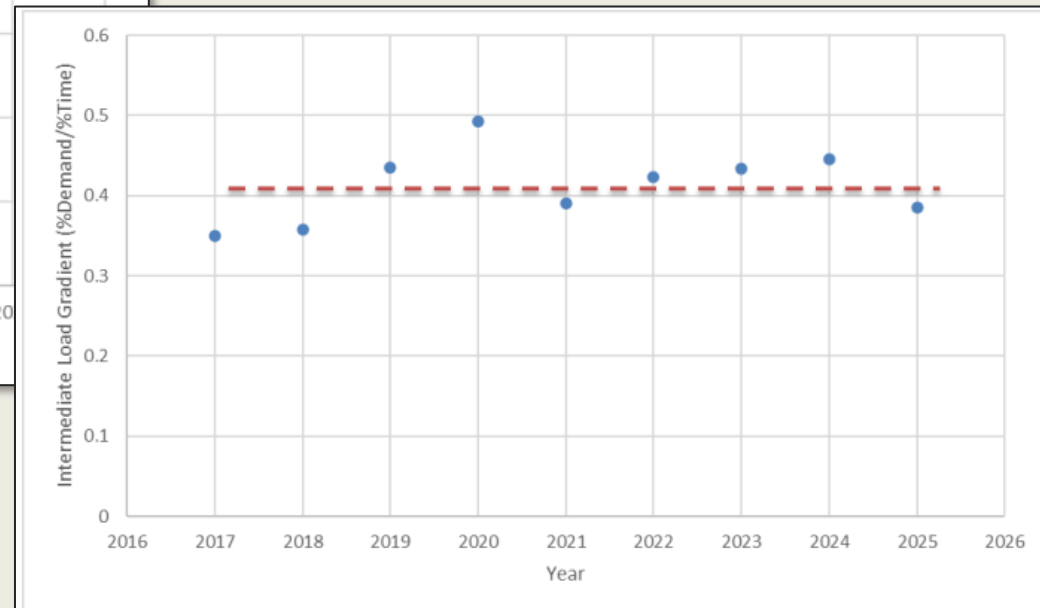
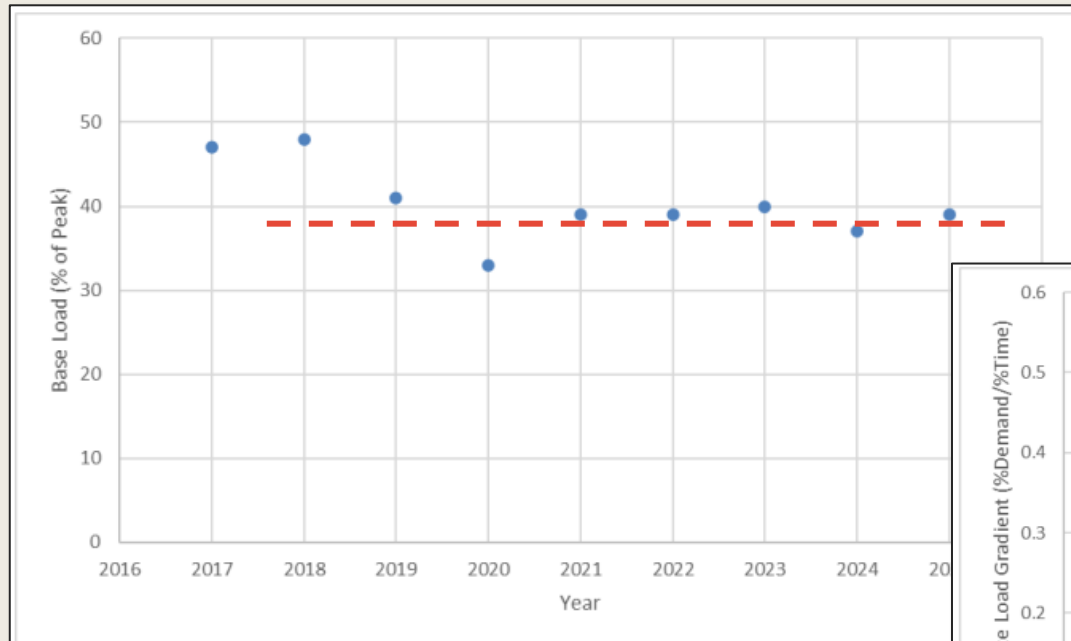
Historic Load Duration Curves of the Northern Region Grid



Second Phase Memorial, Appendix D, Figure 6 (based on historical load duration curves for the Northern Region of India for 2017-2025, P-0718)



Load Curve Parameters



Second Phase Memorial, Appendix D, Figures 6B and 6C



Conclusions

- Pondage computed for the MMD and the characteristics of a Plant.
- Power system load provides the weekly variation in the load, and the distribution of the MMD volume through the week.
- The daily dispatch pattern can be made according to reasonable limits for the duration of operation. Cannot exceed Paragraph 15 limits.
- Capacity used for the daily operation will depend on the energy allocated for each day and the duration of the operation.
- The Pondage required for the week depends on the variation of energy through the week and the daily dispatch pattern for the Plant.

