

# Report on Finalisation of Opening and Closing time ranges of guide vane during turbine and pumping modes of operation in Pumped Storage Plants



May, 2024

| <b>Table of content</b> |                                                                                |                 |
|-------------------------|--------------------------------------------------------------------------------|-----------------|
| <b>Sl. No.</b>          | <b>Description</b>                                                             | <b>Page No.</b> |
| <b>1.</b>               | <b>Introduction</b>                                                            | <b>3</b>        |
| <b>2.</b>               | <b>Development of Pumped Storage Plants</b>                                    | <b>3</b>        |
| <b>3.</b>               | <b>Transient Analysis and Opening &amp; Closing Time Ranges of Guide Vanes</b> | <b>4</b>        |
| <b>4.</b>               | <b>Impact on Electro-Mechanical Equipment</b>                                  | <b>5</b>        |
| <b>5.</b>               | <b>Conclusion</b>                                                              | <b>6</b>        |
| <b>Annexures</b>        |                                                                                |                 |
| <b>Annexure-I</b>       | <b>Constitution of the Committee</b>                                           | <b>7</b>        |
| <b>Annexure-II</b>      | <b>Minutes of the First Meeting of the Committee</b>                           | <b>9</b>        |
| <b>Annexure-III</b>     | <b>Minutes of the Second Meeting of the Committee</b>                          | <b>13</b>       |

## **1. INTRODUCTION**

India has committed to reduce Emissions Intensity of its GDP by 45 percent by 2030 from 2005 level, and achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030. The non-fossil fuel based energy has a very large share of Solar and Wind, which are intermittent & variable sources of energy. Once such huge quantum of Renewable Energy is added to the energy basket of the country, the stable operation of Grid for ensuring '24x7 Power-for-All' will be definitely more challenging than ever before. Given these ongoing energy transitions in the country, the development of PSPs is of paramount importance for providing greater inertia and balancing power to the grid. PSPs are also known as 'the Water Battery', which is an ideal complement to modern clean energy systems.

While battery storage solutions are still evolving, integrating Wind & Solar with time tested and proven Pumped Storage solutions presents an optimal, economically viable & scalable solution to supply Power with both base load and peak load capabilities. Pumped Storage solutions provide the necessary scale (large volume of energy storage) and have a long life cycle resulting in low cost of delivered energy over the life of the projects.

Considering the Grid balancing requirement and benefits enumerated above, several Detailed Project Reports (DPRs) of PSPs have been received in CEA for concurrence. During examination of these DPRs, namely chapter on transient analysis, extreme variations in opening & closing time ranges of guide vane have been observed by appraising agencies of Central Water Commission (CWC) sometimes leading to speed & pressure rises in water conductor system (WCS) beyond the specified limits in the relevant Indian Standards.

To address this concern, a Committee under the chair of Member (Hydro), CEA having representatives from CWC, Original Equipment Manufacturers (OEMs) and Developers was constituted by the Competent Authority vide CEA OM dated 30.10.2023 with following Terms of References (**ToRs**):

1. Defining the operating conditions while carrying out Transient Analysis in both the modes of operation (i.e. turbine and pumping mode), during load rejection & load acceptance in both modes of operations of PSPs, such as single/ multiple unit(s) starting/ stopping etc.
2. Finalization of opening and closing time ranges of Guide Vane to keep the speed rise & pressure rise in limits, as envisaged in relevant Indian Standard.
3. Any other issue/ agenda with the consent of members of the committee

The aforementioned OM along with Minutes of the meetings held are enclosed at **Annexures**.

## **2. DEVELOPMENT OF PSPs**

Hydro Pumped Energy Storage envisages two water reservoirs at different elevations that can generate power as water moves down from higher one to lower one, while passing through a turbine. PSP requires power to pump water back into the upper reservoir during recharge cycle. PSPs can be generally designed for **daily storage of 4–10 Hours**.

There is abundant potential for development of PSPs in the country. The status of development of PSPs is as given below:

i) Potential for On-Stream based schemes is 103 GW (89 nos.). Further, the potential assessment for newly identified Off-Stream based schemes in the country is yet to be taken up, however, it appears to be significant. At present, only self-identified Off-Stream schemes by the Developers are either Under Construction or Under Survey & Investigation (S&I) stage.

**ii) Projects# under Construction and S&I Stage:**

| Region/ State        | ON RIVER       |                         | OFF RIVER      |                         | TOTAL          |                         |
|----------------------|----------------|-------------------------|----------------|-------------------------|----------------|-------------------------|
|                      | No of projects | Installed capacity (MW) | No of projects | Installed capacity (MW) | No of projects | Installed capacity (MW) |
| In Operation         | 8*(6)          | 4745.60<br>(3305.60)    |                |                         | 8*(6)          | 4745.60<br>(3305.60)    |
| Under Construction   | 3              | 1580                    | 1              | 1200                    | 4              | 2780.00                 |
| DPR concurred by CEA | 2              | 2350                    |                |                         | 2              | 2350.00                 |
| Under S&I            | 8              | 11025                   | 33             | 41660                   | 41             | 52685.00                |
| <b>Grand Total</b>   | <b>21</b>      | <b>19700.60</b>         | <b>34</b>      | <b>42860</b>            | <b>55</b>      | <b>62560.6</b>          |

#This is dynamic and may change. The data is based on information available on CEA Website  
 \*only 6 out of 8 Projects are under operation in pumping mode.

**3. TRANSIENT ANALYSIS AND OPENING & CLOSING TIME RANGES OF GUIDE VANES**

PSPs play an important role in the peak regulation of power grid. Accordingly, the hydraulic pump-turbine needs to frequently change its operating conditions and experiences many transient processes. The transient process in PSPs, including the interactions among hydraulics, mechanism, and electricity, is complicated. The closure of guide vanes and Spherical Valve/ Main Inlet Valve induces a change in the flow inertia, which causes changes in the turbine rotational speed and hydraulic pressure in WCS.

When the working condition dramatically changes during transients, drastic changes in the water-hammer pressure and high rotational speed may lead to serious accidents that will endanger the safety of the hydraulic structure & pump-turbine unit and affect the power grid stability. Therefore, simulating the transient process of hydropower stations is necessary. The calculation accuracy affects the design of the water conductor system, safe operation of PSP and power quality.

It may be mentioned that the transient depends upon the length of the WCS (L) & Head (H) and the thumb rule of L/H ratio broadly determines requirement of surge shaft, which in turn effects the pressure rise/fall that would take place in the WCS if there is a certain closure/ shutdown.

Since the submission of large numbers of DPRs of PSPs in the last few years, while examining the chapter(s) related to transient analysis, the following points are observed:

- The surge shaft is avoided in the water conductor system due to non-availability of good geological conditions or to reduce the overall civil costs.
- Increasing the guide vane opening/closing from the conventional 15/8 seconds to

25/25 seconds or more.

- Providing multiple time step closure such as 70% -95% closure in the first step & 5%-30% in the second step with varying time ranges.
- Varying the Moment of Inertia of the Machine.

On examination of the submitted transient analysis, it is noticed that the pumping mode comes out to be more critical leading to both high pressure rise and negative pressure in the Water Conductor System (WCS).

It may be noted that the matter becomes critical in case of sudden tripping of the units or power failure in the pumping mode and the time of closure of the machine plays an important role to accommodate the pressure rise & speed rise within limits.

The relevant details in respect of transient analysis for few PSPs (under Pre-DPR Stage as well as operational) are as follows:

| Sl. No. | Name of the Project        | Provision of Surge Shaft (Yes/ No) | Guide Vane (in Sec)              |                                                                                  | Thickness of Steel Liner (in mm) |
|---------|----------------------------|------------------------------------|----------------------------------|----------------------------------------------------------------------------------|----------------------------------|
|         |                            |                                    | Opening Time                     | Closing Time                                                                     |                                  |
| 1       | Purulia PSP, West Bengal   |                                    |                                  |                                                                                  |                                  |
| 2       | Bhira PSP, Maharashtra     | Yes                                | 30                               | 27                                                                               | 53                               |
| 3       | Bhivpuri PSP, Maharashtra  | Yes                                | 30/35                            | Generation-15 s<br>Pumping-30 s                                                  | 56                               |
| 4       | Shirawata PSP, Maharashtra | No                                 | 30                               | Generation- 15s<br>Pumping-30 s                                                  | 50                               |
| 5       | Saundatti PSP, Karnataka   | No                                 | Generation - 40s<br>Pumping- 25s | Generation- 35s<br>Pumping-25 s                                                  | 62                               |
| 6       | Turga PSP, West Bengal     |                                    |                                  |                                                                                  |                                  |
| 7       | Bhavali PSP, Maharashtra   | No                                 | 35                               | Generation- 11.5 s<br>Pumping-35 s                                               | 54                               |
| 8       | Tarali PSP, Maharashtra    | Yes                                | 30                               | Generation- 70% in 8 s, 30 % in next 7 s<br>Pumping-95% in 10 s, 5% in next 20 s | 56                               |

#### **4. IMPACT ON ELECTRO-MECHANICAL EQUIPMENT**

During the process of approval of DPRs of PSPs, the Civil, Hydro-Mechanical as well as Electro-Mechanical components are firmed up/ finalised and no changes would be allowed in the finalised locations of upper & lower reservoirs, power house complex and layout of water

conductor system, as all the geological investigations would have been completed. However, minor modifications in the water conductor system may be acceptable, based on outcome of model studies.

Each conventional HEPs as well as PSPs being tailor-made & site-specific, the parameters for guide vanes are firmed up during the model study/ hydraulic design of turbine at detailed design engineering stage. But it is important that Pre-DPR chapters of PSPs being prepared by the consultants, adopt guide vanes operating time and EM parameters within a band of acceptable range during preliminary stage so that the same could be reasonably optimized during detailed design engineering stage.

During the discussion, the OEMs informed that generally turbine mode is critical from transient consideration and their experience with recent PSP projects shows that pump power failure mode is not critical and can be managed in E&M design. However, it may not be possible for them to manage the negative pressure in WCS in some cases. It may be noted that the limits of speed and pressure rises shall be restricted to those defined in the relevant Indian Standard during detailed engineering.

## **5. CONCLUSIONS**

During the detailed deliberations amongst the committee members, the main concern/ issue, while examining the Pre-DPR chapters of PSPs, seems to be the 1) requirement/omission of surge shaft

2) Increasing the guide vane opening/closing time beyond conventional values. Therefore, a thumb rule for following related values may be accepted and workable for E&M suppliers during detailed design engineering, considering which as upper limits, the transient analysis may be carried out during Pre-DPR Stage:

- a) Generator with inertia constant (H) up to four, i.e. a motor-generator with H constant up to 4 (four).
- b) Water starting time to be less than 3.1 seconds.
- c) The opening and closing times of maximum up to 45 seconds.
- d) The transient analysis for complete water conductor system from intake to tailrace incorporating pump/turbine parameters shall be undertaken. All the transient conditions need to be checked. As per OEMs experience, in general, the turbine mode is likely to be the most critical from transient considerations.

Pressure rise and speed rise limits prescribed in IS code shall always be adhered to by E&M equipment suppliers/ OEMs. There shall be no negative pressure in the water conductor system.

The developer shall submit an undertaking that there shall be no major change in the civil components' layout during the detailed E&M design stage. The developer shall also obtain the views of the E&M supplier during DPR stage itself to avoid any major changes in the design approved at DPR stage.

I/31298/2023()



भारत सरकार/**Government of India**  
 वि द्युत मंत्रालय/**Ministry of Power**  
 केंद्रीय वि द्युत प्राधि करण/**Central Electricity Authority**  
 जल वि द्युत अभि यां त्रि की व प्रौद्योगि की वि कास प्रभाग  
**Hydro Engg. & Technology Dev. Division**  
 सेवा भवन, आर. के. पुरम-1, नई दि ल्ली -110066  
**Sewa Bhawan, R. K. Puram-1, New Delhi-110066**

:टेली /Tele  
**011-26732789**  
 ईमेल/Email: [hetdcea@nic.in](mailto:hetdcea@nic.in)  
 वेबसाइट/Website  
[www.cea.nic.in](http://www.cea.nic.in)

No. 10/3/HE&amp;TD/2023/

Date: .10.2023

**OFFICE MEMORANDUM**

**Subject:** Constitution of Committee for Finalisation of opening and closing time ranges of guide vane during turbine and pumping modes of operation in PSPs - Reg.

Owing to huge penetration of inherently variable & intermittent Renewable Energy (i.e. Solar & Wind) into the Indian Grid, several proposals for setting up the PSPs have been received in CEA, which are proven and reliable energy storage system for the requirement of balancing the Grid.

However, during the examination of DPRs of these PSPs, concerned appraising agency has observed in the transient analysis studies carried out by respective developers that the integrity/ stability of water conductor system may not be adequate and limits of pressure rise & speed rise of the machine may have been violated beyond those specified in relevant Indian Standard.

In this regard, the competent authority has constituted a committee under the chair of Member (Hydro), CEA with the following members & terms of reference (ToRs):

|   |                                  |                                                |
|---|----------------------------------|------------------------------------------------|
| 1 | Member (Hydro), CEA              | <b>Chairman</b>                                |
| 2 | Chief Engineer (HPP&I), CEA      | Member                                         |
| 3 | Chief Engineer (HETD&RM), CEA    | Member & Convener                              |
| 4 | 02 Representatives of CWC        | Member, Not below the rank of Director         |
| 5 | Representative of WBSEDCL        | Member, Not below the rank of ED/ GM           |
| 6 | Representative of BHEL           | Member, Not below the rank of ED/GM            |
| 7 | Representative of M/s Greenko    | Member, Not below the rank of ED/ GM           |
| 8 | Representative of M/s Tata Power | Member, Not below the rank of VP or equivalent |
| 9 | Representative of M/s Voith      | Member, Not below the rank of VP or            |

I/31298/2023(9)

|    |                               |                                                  |
|----|-------------------------------|--------------------------------------------------|
|    |                               | equivalent                                       |
| 10 | Representative of M/s Toshiba | Member, Not below the rank of VP<br>orequivalent |
| 11 | Representative of M/s GE      | Member, Not below the rank of VP<br>orequivalent |
| 12 | Representative of M/s Andritz | Member, Not below the rank of VP<br>orequivalent |

The committee may co-opt any other member, if required.

**Terms of Reference (ToRs):**

1. Defining the operating conditions while carrying out Transient Analysis in both the modes of operation i.e. turbine and pumping mode, during load rejection & load acceptance in both modes of operations of PSPs, such as single/ multiple unit(s) starting/ stopping etc.
2. Finalization of opening and closing time ranges of guide vane to keep the speed rise & pressure rise in limits, as envisaged in relevant Indian Standard.
3. Any other issue/ agenda with the consent of members of the committee.

The committee shall submit its report within 04 weeks from the date of the firstmeeting of the committee.

Signed by Reetesh Tiwari (Reetesh Tiwari)

Date: 30-10-2023 16:23:37 Dy. Director

Reason: Approved

**To**

i

1. Member (D&R), Central Water Commission
2. Chief Engineer (HPP&I), CEA
3. CMD (WBSEDCL/ BHEL)
4. VP (M/s Tata Power/ M/s Greenko/ M/s Voith/ M/s Toshiba/ M/s Andritz/ M/s GE)

**Copy for kind information to:**

1. SA to Chairperson, CEA.
2. SA to Member (Hydro), CEA





भारत सरकार/Government of India  
वि द्युत मंत्रालय/Ministry of Power  
केंद्रीय वि द्युत प्राधि करण/Central Electricity Authority  
जल वि द्युत अभि यांत्रि की व प्रौद्योगि की वि कास एवं नवी नी करण व आधुनि कीकरण  
प्रभाग  
Hydro Engg. & Tech. Dev. and Renovation &  
Modernization Division  
सेवा भवन, आर. के. पुरम-1, नई दि ल्ली -110066  
Sewa Bhawan, R. K. Puram-1, New Delhi-110066

टेली /Tele:  
011-26732789  
ईमेल/Email:  
[hetdcea@nic.in](mailto:hetdcea@nic.in)  
वेबसा इट/Website:  
[www.cea.nic.in](http://www.cea.nic.in)

10/03/HE&TD/2023/

Date: /11/2023

**Subject:** Minutes of the First Meeting of the Committee on Finalization of Opening and Closing time ranges of Guide Vane during turbine and pumping modes of operation of PSPs held at 03:00 PM on 07<sup>th</sup> November, 2023 at Central Electricity Authority, New Delhi - reg.

Please find enclosed herewith Minutes of the First Meeting of Committee on subject matter for your kind perusal.

**Enclosure:** As above

Signed by Shyam Singal  
Date: 28-11-2023 12:32:59  
Reason: Approved  
(श्याम सिंगल)  
सहायक निदेशक

To:

Committee Members

Minutes of First Meeting (MoM) of the Committee for finalization of Opening and Closing Time Ranges of Guide Vane during Turbine and Pumping modes of operation in PSPs

List of Participants is given at Annexure-1.

1. At the outset of first meeting of the committee, held at 3 PM on 07.11. 2023 at CEA HQ, New Delhi, the chair, Member (Hydro), CEA welcomed all the committee members and emphasized on the smooth & hassle-free clearances of the DPRs of PSPs, so as to cater the need of storage systems for balancing the Grid against the huge penetration/ addition of inherently variable & intermittent RE into the Grid.
2. The member convener of the committee, Chief Engineer (HETD&RM), CEA apprised the committee members that the objective of this committee is to firm up the opening & closing time ranges of guide vanes in turbine as well as pumping modes of operations of PSPs during transient studies analysis particularly during sudden load rejection in pumping mode so as to keep the pressure & speed rises within the limits as specified in relevant Indian Standard(s), which is main cause of concern for the appraising agency, i.e. CWC as well as developers.
3. In this regard, a presentation by CEA was also given to the committee regarding the objective, constitution, Terms of Reference and Timelines of committee.
4. Sh. Darpan Talwar, Director, CWC addressed the committee on the civil aspect and stated that generally, the opening and closing time of the guide vanes is kept between 8-12 seconds or at the best 15 or may be increased to 20 seconds. Further, the transient depends upon the length of the water conductor system (WCS) & head and the thumb rule of L/H ratio broadly determine how much pressure rise would take place in the WCS if there is a certain closure /shutdown. However, since the submission of large numbers of DPRs of PSPs in the last few years, the tendency of most of the developers for cutting the cost by omitting the surge shaft has been observed. Apart from this, due to increase in L/H ratio, the developers are trying to accommodate the pressure and speed rises by increasing the guide vane opening time from the conventional 15 second to 20 seconds and more, till the desired result and it is being kept on increasing gradually. It may be noted that the matter becomes critical in case of sudden tripping of the units or power failure in the pumping mode and the time of closure is very important. It is observed that early closure leads to huge pressure rise in the order of more than 100% and in some cases, even 200%. As far as steel liner design is concerned, we have no problem except one or two projects, however, in such cases of huge pressure rise, how E&M equipment are going to respond/ behave.
5. Smt. Rekha Rani, Director, CWC stated that projects with variable time of guide vane closing and two step closures have been received such as 70% closure in first stage & 30% in second and various other combinations. However, it is not clear as how much closure should be there in each stage. Further, another issue of the moment of inertia relating to EM32 have also been observed.

6. Representative of BHEL stated that the problem may not have a straightforward answer, as each conventional HEPs as well as PSPs are tailor-made & site-specific. Further, the parameters for guide vanes are firmed up during the model study of turbine at detailed design engineering stage. As such, it may be noted that guide vane opening time ranges vary for the large pumps supplied by BHEL for Lift Irrigation Schemes in the country.
7. Representative of M/s Andritz stated that the problem statement may be the best left with the manufacturers, who may fix it. As this question is being asked at the DPR stage, it may be noted that none of the manufacturers are going to spend effort and time to do transient analysis at this stage. Further, the problem can be handled during detailed design engineering stage by slightly changing the geometry of the WCS. As far as the consultants involved in the preparation of DPR are concerned, the study by them based on the relevant Indian/ International Standards applicable at this preliminary planning stage may be accepted. As such, the manufacture are going to restrict the speed and pressure rise limits defined in the relevant IS during detailed engineering and the problem statement may not be applicable for E&M part.
8. Representatives of BHEL, M/s Voith, M/s Toshiba, M/s Greenko and M/s Tata Power unanimously agreed with the views of M/s Andritz. Further, Representative of WBSEDCL also submitted that the opening & closing time of guide vanes are approximately 45 seconds for the operational Purulia PSP.
9. On the changes in the WCS at construction stage, Sh. Darpan Talwar, Director CWC stated that the changes in the finalised layout may happen due to geological surprises and changes in WCS up to certain limit may be acceptable at construction stage.
10. Member (Hydro), CEA stated that convergence seems not be possible and the committee members may try to find out more data/ literature etc. on the subject matter.
11. CE (HETD&RM) concluded the meeting with the followings:
  - The exact timings/ time ranges for the opening and closing of guide vanes in turbine and pumping mode for different projects may not be specified.
  - The problem statement may be rephrased which was raised at the time of the constitution of the committee to address the concerns of CWC for designing of the water conductor system.
  - Sudden power failure/ closure during pumping mode is critical and what parameters along with speed and pressure rise may be considered.
  - In the next round of discussion, one case study for deliberation may be taken.

The meeting ended with a vote of thanks to the chair.

**List of Participants****CEA**

1. Sh. M. A. K. P Singh, Member (Hydro)- in Chair
2. Sh. Pankaj Kumar Gupta, Chief Engineer (HETD&RM)
3. R. P. Pradha, Chief Engineer (HPP&I)
4. Sh. Mukesh Kumar, Deputy Director (HETD&RM)
5. Sh. Reetesh Tiwari, Deputy Director (HETD&RM)
6. Sh. Shrey Kumar, Deputy Director (HETD&RM)
7. Sh. Shyam Singal, Asst. Director (HETD&RM)
8. Sh. Kunal Saurav, Asst. Director (HETD&RM)

**CWC**

9. Sh. Darpan Talwar, Director
10. K. Rekha, Director
11. K. Vysakh, Deputy Director
12. Sh. Amit Gupta, Deputy Director
13. Sh. Sajal Mittal, Assistant Director

**BHEL**

14. Sh. V. Shrinivas Rao, GM (Hydro)

**TATA Power**

15. Sh. Prabhakar Kale, Chief (Hydro)
16. Sh. Vivek Mate, GM (Hydro)

**WBSEDCL**

17. A. Sarkar
18. S. Samanta
19. M. Tibriwalla

**M/s Greenko**

20. Om Prakash, Sr. GM
21. Mr. P.V. Ramana, AVP

**M/s Toshiba India**

22. Sh. KO Kawashima, VP
23. Sh. DeepParakash, VP

**M/s Voith Hydro**

24. Sh. Sanjai Dhar Dwivedi, AVP

**M/s Andritz Hydro**

25. Rohit Uberoi,VP



भारत सरकार/Government of India  
विद्युत मंत्रालय/Ministry of Power  
केंद्रीय विद्युत प्राधिकरण/Central Electricity Authority  
जल विद्युत अभियांत्रिकी व प्रौद्योगिकी विकास एवं नवीनीकरण व आधुनिकीकरण प्रभाग  
Hydro Engg. & Tech. Dev. and Renovation & Modernization Division  
सेवा भवन, आर .के .पुरम-1, नई दिल्ली-110066  
Sewa Bhawan, R. K. Puram-1, New Delhi-110066

टेली/Tele:  
011-26732789  
ईमेल/Email:  
[hetdcea@nic.in](mailto:hetdcea@nic.in)  
वेबसाइट/Website:  
[www.cea.nic.in](http://www.cea.nic.in)

10/03/HE&TD/2024/

Date: 08/05/2024

**Subject:** Minutes of the Second Meeting of the Committee on Finalization of opening and closing time ranges of guide vane during turbine and pumping modes of operation in PSPs held at 03:00 PM on 20<sup>th</sup> December, 2023 at Central Electricity Authority, New Delhi - reg.

Please find enclosed herewith Minutes of the Second Meeting of Committee on subject matter for your kind perusal.

**Enclosure:** As above

**Signed by Shyam Singal**  
**Date: 08-05-2024 12:23:59**

(श्याम सिंगल)  
सहायक निदेशक

To:

1. Committee Members

Copy to:

1. SA to Chairperson, CEA
2. SA to Member (Hydro), CEA

## **Minutes of Second Meeting (MoM) of the Committee for finalization of Opening and Closing Time Ranges of Guide Vane during Turbine and Pumping modes of operation in PSPs**

List of Participants is given at Annexure-1.

1. At the outset of second meeting of the committee, held at 3 PM on 20.12.2023 at CEA HQ, New Delhi, the chair, Sh. Darpan Talwar, Director, CWC welcomed all the committee members and gave a brief of the first meeting and purpose of this meeting. He stated that the main concern of CWC is key time of opening and closing of guide vanes and developers have increased the same to 45 second or even longer. In respect of Pt. 9 of MoM of first meeting dated 07.11.2023, it was clarified that once the components have been decided/ firmed up, it would not be changed/ altered, as all the geological investigation would have already completed. However, minor modifications in the water conductor system may be acceptable. As such, ideal opening and closing time ranges may be known to finalize the scheme.
2. Representative of M/s Andritz stated that the concern/ issue of CWC is well understood, which seems as to whether a surge shaft is needed and as to how it may impact (positively or negatively) the E&M works. Therefore, a thumb rule for related values may be presented & accepted, which are as follows and workable for E&M suppliers:
  - a) Generator with inertia close to four, i.e. a motor generator close to H constant of 4 (four).
  - b) Water starting time may be less than 3 – 3.1 secs.
  - c) The opening and closing times of at least up to 40 secs.
  - d) Pressure rise and speed rise limits prescribed shall always be adhered to by E&M suppliers and there shall be no negative pressure in the WCS.
3. Representatives of BHEL, agreeing to aforementioned values, stated that with these values as upper limits, the transient analysis may be carried out iteratively. Further, M/s Voith, M/s Greenko and M/s Tata Power also agreed with the same.
4. CWC enquired about the minimum closing time of the guide vanes, for which E&M suppliers unanimously stated for minimum closing time around 7 to 8 seconds.
5. Further, CWC stated that while examining DPRs of PSPs, it is observed that the pumping mode come out to be more critical leading to negative pressure rise in the WCS. E&M suppliers unanimously stated for Turbine mode as the most critical in general, however, it may not be possible for them to manage the negative pressure in WCS in some cases.
6. Sh. Darpan Talwar, Director, CWC, concluded the meeting and suggested to have a final concluding meeting in the presence of Member Hydro, CEA with the suitable inclusion of aforementioned values in the final report.

The meeting ended with a vote of thanks to the chair.

**Annexure -I****List of Participants:****CEA**

1. Sh. Raj Kumar Jaiswal, Director (HETD&RM)
2. Sh. Reetesh Tiwari, Deputy Director (HETD&RM)
3. Sh. Shyam Singal, Asst. Director (HETD&RM)

**CWC**

4. Sh. Darpan Talwar, Director- in Chair
5. Sh. Amit Gupta, Deputy Director

**BHEL**

6. Sh. Saurav Sharma, Sr. GM (Hydro)

**TATA Power**

7. Sh. Vivek Mate, GM (Hydro)

**M/s Greenko**

8. Sh. P.V. Ramana, AVP - Through VC

**M/s Voith Hydro**

9. Sh. Sanjai Dhar Dwivedi, AVP- Through VC

**M/s Andritz Hydro**

10. Sh. Rohit Uberoi, VP- Through VC