BUREAU OF INDIAN STANDARDS

MINUTES

23rd Meeting of Water Conductor Systems Sectional Committee, WRD 14		
Day and Date	**Time**	**Venue :**
Monday, 03rd June 2024	From 10:30 A.M.	Hybrid Venue at Committee Room (R-625), 6th Floor, Sewa Bhawan.
Chairperson: SHRI VIJAI SARAN, CHIEF ENGINEER, DESIGN (NW&S), CWC	**Member Secretary**: SHRI NAVDEEP YADAV, ASSISTANT DIRECTOR, WRD, BIS	

PARTICIPANTS:

S.no	Name	Email
1.	Shri Narendra Singh Shekhawat, Director, HCD (N&W), CWC	Present physically
2.	Shri Maghesh Kr. Singh, Deputy Director, HCD (NW&S), CWC	Present physically
3.	Shri K. Vysakh, Deputy Director, HCD E&NE, CWC	Present physically
4.	Shri Rajeev Kumar Tank, Deputy Director, HCD (N&W), CWC	Present physically
5.	Shri Sajal Mittal, Deputy Director, HCD (NW&S), CWC	Present physically
6.	Shri Vikash Yadav, Asstt. Director, HCD (NW&S), CWC	Present physically
7.	Shri Bibeka Kalita, NEEPCO	bibeka_kalita@yahoo.co.in
8.	Shri D. P. Dangwal, GSI	devi.dangwal@gsi.gov.in
9.	Shri Sankhadip Chowdhury, NHPC Ltd.	rbhatnagar@nhpc.nic.in
10.	Dr K K Pandey , IIT BHU	kkp.civ@iitbhu.ac.in
11.	Dr Nayan Sharma, In Personal Capacity	nayanfwt@gmail.com

12.	Dr. Ajay Kumar, GSI	ajay.kumar1@gsi.gov.in
13.	Dr. D P Shukla ,IIT Mandi	dericks@iitmandi.ac.in
14.	Dr. Pramod Soni, IIT BHU	pramod.civ@iitbhu.ac.in
15.	Dr. V. Surya Anantpantula, PES Engineers Pvt. Ltd	docavsurya@peseng.net
16.	Er. R. K. Kaundal, HPPCL	gmdesigns6672@gmail.com
17.	Prof Gopal Das Singhal, In Personal Capacity	gopal.singhal@snu.edu.in
18.	Shri Hari Dev, CSMRS	haridev@nic.in
19.	Prof Janga Reddy Manne, IIT Bombay	mjreddy@civil.iitb.ac.in
20.	Shri M. Z Qamar, CWPRS	ziaul_qamar@rediffmail.com
21.	Dr. Manish Pandey, IIT Kharagpur	mpandey@nitw.ac.in
22.	Smt Manjusha Mishra, NHPC	mnigam@nhpc.nic.in
23.	Shri Manoj Verma, CWPRS	manoj_rajyog@rediffmail.com
24.	Shri Mukesh Kumar, CEA	kumar.mukesh788@nic.in
25.	Prof Pradip K Tewari ,IIT Jodhpur	head_che@iitj.ac.in
26.	Shri Rajeev Dir WR BBMB	goyal_rkg2003@yahoo.com
27.	Shri Reetesh Tiwari, Dy. Director, CEA	reeteshtiwari.cea@nic.in
28.	Shri Shyam Singal, CEA	shyam.singal@cea.nic.in
29.	Smt Sushma Vyas, CWPRS, Pune	vyassush13@gmail.com
30.	Prof. Subashisa Dutta, IIT Guwahati	subashisa@iitg.ac.in

Item 0 WELCOME AND INTRODUCTORY REMARKS

Chairman extended his warm welcome to all the members present in the 23rd meeting of WRD 14 Sectional Committee. Chairman requested all the members for their active contribution and regular participation in the meeting so that effective deliberation can be done in the Committee.

Item 1 CONFIRMATION OF THE MINUTES OF THE LAST MEETING

The Committee NOTED that no comments were received on the circulated minutes. The Committee therefore CONFIRMED the minutes of the previous meeting as circulated.

Item 2 COMPOSITION OF THE COMMITTEE

2.1 The Committee NOTED the present Composition of the Committee as given in Annex 1 of the agenda. The Committee decided the organizations that had not attended the last three meetings and are not present in this meeting may be pursued one last time for active participation, otherwise, steps may be taken by BIS to find suitable replacement.

2.2 The Committee NOTED item 2.2 of the agenda regarding new nominations received from the following IITs and decided to co-opt them in the Committee as per the details given below:

S. No.	Organization	Member Nominated
1)	IIT Guwahati	Prof Subashisa Dutta, Professor (HAG) Prof. (Dr.) Mihir Kumar Purkait, Professor Chair of ministry of Jal Shakti (DDWS) (*Alternate)*
2)	IIT (BHU), Varanasi	Dr. K. K. Pandey, Associate Professor Dr. Pramod Soni, Associate Professor *(Alternate)*
3)	IIT Kharagpur	Dr. Manish Pandey, Associate Professor
4)	IIT Bombay	Prof. Manne Janga Reddy, Professor Prof. T. I Eldho, Professor *(Alternate)*

Further, the Committee noted that fresh nominations received from HCC Ltd are same members who have not attended the last three meetings and are also not present in this meeting. The Committee directed Member Secretary to pursue telephonically and obtain different nominations from the organization.

2.3 The nomination received from DMR Hydro Engineering (non-member private organization) was not sought by the Committee. It was decided that this nomination may be considered when other private organisations are being considered for inclusion in the Committee as per the norms of BIS.

Item 3 TITLE, SCOPE AND PROGRAMME OF WORK OF WRD 14

3.1 The Committee NOTED the Present Scope and Programme of work.

Item 4 DRAFT STANDARD FOR FINALIZATION

4.1 Doc. No. WRD 14(18185) Code of Practice for Design of Tunnels Conveying Water Part 4 Structural Design of Concrete Lining in Rock [First Revision of IS 4880 (Part 4): 1971]

{Earlier Document no. WRD 14 (11673)}

The Committee noted and deliberated on input received from CSMRS and the view of the working group on the input. The Committee deliberated and agreed with the view of the working group as given below.

Page No	Location	REMARKS	Addition/ Modification Suggested	Reply received from CSMRS	The decision of the Working group in the meeting held on 04 March 2024	Decision of the Committee in the meeting
19	Ø=the angle of repose of the soil	The description of Ø may be checked as in figure 5 the rock load around the cavity may be due to rock.	The word rock may be added. Ø = the angle of repose of the soil / rock	The 'the angle of repose of the soil' may please be replaced with 'friction angle of rock'	May be replaced with '**friction angle of rock mass**'.	The Committee agreed with the view of the WG.

The Committee noted and deliberated on the reconciliation of formulae in Annex D of the draft document. The Committee reviewed and updated the composition of the working group (WRD14/WG-1) as given below.

1. Shri Sankhadip Chowdhary, National Hydroelectric Power Corporation, (Convenor WRD 14/WG-1)
2. Representative from Geological Survey of India
3. Shri Hari Dev Central Soil & Materials Research Station
4. Representative from Central Institute of Mining & Fuel Research.
5. Dr. K. K. Pandey, IIT BHU.

The Committee requested the nominated experts for their active participation in the reconciliation of the formulas. The Committee also directed the Member Secretary to seek willingness from nominated experts from IITs and other experts with structural engineering background and include them in the working group WG-1. The Committee further decided to drop the document and recirculate the document afresh with new document number, as finalized by the working group WG-1 among the Committee members for inputs, which shall be discussed in the next meeting.

Item 5 DRAFT STANDARDS FOR APPROVAL FOR WIDE CIRCULATION

5.1 Doc. No. WRD 14 (19357), IS 9761: 1995 Hydropower intakes – Criteria for Hydraulic Design [Second Revision of IS 9761]

{Earlier Document no. WRD 14(15243) C}

The Committee noted item 5.1 of the agenda. The Committee deliberated on the status of the draft document, which is under discussion in the Working Group (WG-2). Deputy Director, HCD E&NE, CWC, informed the Committee that two working group meetings have been convened on 18 March 2024 and 27 May 2024 respectively, and the initial draft has been prepared and circulated among the working group for giving further comments by 15 June 2024. A working group meeting is also planned after inputs are received from the working group experts. The Committee requested the working group members to expedite the finalisation of document and decided to drop the earlier document and adopt the document as finalized by the working group. The Committee directed the Member Secretary to circulate the finalized document as received from the working group as a P-draft document for seeking views/comments from the Committee members. The Committee decided to take up the views/comments of Committee members on P-draft in the next meeting.

The Composition of WRD14/WG-2:

1. Director. HCD (E&NE), CWC (Convenor)
2. Representative from Central Water & Power Research Station
3. Representative from IIT Roorkee
4. Prof. Nayan Sharma, In Personal Capacity
5. Representative from National Hydroelectric Power Corporation
6. Representative from THDC India Limited
7. Representative from SJVN Limited

ITEM 6 COMMENTS ON PUBLISHED STANDARDS

6.1 Criteria for Hydraulic Design of Surge Tanks: Part 1 Simple, Restricted Orifice and Differential Surge Tanks (Second Revision of IS 7396 (Part 1))

6.2 Criteria for Hydraulic Design of Surge Tanks: Part 2 Tail Race Surge Tanks (Second Revision of IS 7396 (Part 2))

The Committee NOTED items 6.1 & 6.2 of the agenda. The Committee deliberated on the comments received from NHPC and unresolved comment of SJVNL. Regarding comments on load acceptance criteria, CEA clarified that the report being referred by NHPC was not accepted by CEA. The Committee directed Member Secretary to write a letter to CEA for their detailed input. The Committee also requested CEA and NHPC to provide the details of other organisations who may provide relevant inputs in this regard and may be included in the Committee. Further, the Committee decided to form a working group in consultation with the Chairperson after receiving details of such organisations.

ITEM 7 DOCUMENTS UNDER REVISION

7.1 Criteria for Structural Design of Penstocks Part 2 Buried / Embedded Penstocks in Rock [First revision of IS 11639 (Part 2): 1995]

The Committee NOTED item 7.1 of the agenda. The Committee deliberated on the status of the draft document that is long pending from the SNC Lavalin. The Committee decided to constitute working group (WRD 14/WG-3) for preparation of the draft document with the following composition:

1. Director. HCD (E&NE), CWC (Convenor)
2. Representative from National Hydro Power Corporation
3. Representative from THDC India Limited
4. Representative from SJVN Limited

The Committee directed the Member Secretary to contact SNC Lavalin and obtain the draft document available so that the working group can take it forward. The Committee also authorized the Convenor of the working group (WRD 14/WG-3) to include any additional experts from IITs as deemed suitable.

Further, comments received from HPPCL are placed in Annex 1 for seeking views of CEA in the working group (WRD 14/WG-3).

ITEM 8 STANDARDS TAKEN FOR REVISION

Sl. No.	IS Number	IS Title	Panel Members to whom the standard allotted
1.	IS 4880 (Part 1) : 1987	Code of practice for design of tunnels conveying water Part 1 general design First Revision	SJVNL - Shri Rakesh Sehgal, Shri Revati Raman CWPRS - Shri Y N Srivastava, Shri M. K. Verma, Mrs. Sushma Vyas NHPC - Ms. Shashi Prasad, Sh. Arunesh Bihari Dwivedi CWC - Ms. K Rekha Rani
2.	IS 5878 (Part 1) : 1971	Code of practice for construction of tunnels conveying water Part 1 precision survey and setting out	SJVNL - Shri Rakesh Sehgal, Shri Revati Raman THDC - Shri Anirudh Bishnoi, Shri Atul Jain CWC - Ms. K Rekha Rani
3.	IS 7916 : 1992	Open power channels - Code of practice First Revision	Prof. Nayan Sharma (in personal capacity) CWPRS - Shri Y N Srivastava, Shri M. K. Verma, Mrs. Sushma Vyas IIT Roorkee - Prof Zulfequar Ahmad

			THDC - Shri Anirudh Bishnoi, Shri Atul Jain CWC - Shri Narendra Singh Shekhawat
4.	IS 11388 : 2012	Recommendations for design of trash racks for intakes Second Revision	SJVNL - Shri Rakesh Sehgal, Shri Revati Raman CWPRS - Shri Y N Srivastava, Shri M. K. Verma, Mrs. Sushma Vyas NHPC - Ms. Shashi Prasad, Sh. Arunesh Bihari Dwivedi THDC - Shri Anirudh Bishnoi, Shri Atul Jain CWC - Ms. K Rekha Rani
5.	IS 11639 (Part 3) : 1996	Structural design of penstock - Criteria Part 3 specials for penstocks	SJVNL - Shri Rakesh Sehgal, Shri Revati Raman HPPCL - Er. R.K. Kaundal Er. Sanjay Kumar Rana THDC - Shri Anirudh Bishnoi, Shri Atul Jain CWC - Shri Narendra Singh Shekhawat
6.	IS 12633 : 1989	First filling and emptying of pressure tunnels - Guidelines	SJVNL - Shri Rakesh Sehgal, Shri Revati Raman THDC - Shri Anirudh Bishnoi, Shri Atul Jain CWC - Ms. K Rekha Rani
7.	IS 13495 : 1992	Design of sediment excluders - Guidelines	CWPRS - Shri Y N Srivastava, Shri M. K. Verma, Mrs. Sushma Vyas NHPC - Ms. Shashi Prasad, Sh. Arunesh Bihari Dwivedi CWC - Shri Narendra Singh Shekhawat
8.	IS 15310 : 2003	Hydraulic design of pump sumps and intakes - Guidelines	CWPRS - Shri Y N Srivastava, Shri M. K. Verma, Mrs. Sushma Vyas IIT Roorkee - Prof Zulfequar Ahmad NHPC - Ms. Shashi Prasad, Sh. Arunesh Bihari Dwivedi CWC - Ms. K Rekha Rani

The Committee NOTED item 8 of the agenda. The Committee deliberated on the decisions of the panels on the standards IS 4880 Part 1, IS 13495, and IS 15310. The decisions taken in the meeting regarding these standards are attached to the minutes of the meeting as Annexure 2,3 & 4 respectively. The Committee also noted that inputs have been provided by Dr. Nayan Sharma on IS 7916 and requested the panel group to review the inputs and submit their views for deliberation in the next meeting. The Committee also decided to take up the review of the remaining four standards and further requested the panel groups to submit their inputs for deliberation in the next meeting.

ITEM 9 NEW SUBJECTS FOR CONSIDERATION

9.1 Guidelines for Design of Branching in Penstocks for Hydro Electric Projects

{Earlier Doc. No. WRD14 (496)}

The Committee NOTED item 9.1 of the agenda. The Committee deliberated on the status of the draft document that was pending from the SNC Lavalin. The Committee directed the Member Secretary to request the SNC Lavalin for submission of their work done on the subject within 10 days to BIS so that the working group (WRD 14/WG-3) can take their work forward. As no representative from SNC Lavalin was present, the Committee directed the Member Secretary to write a letter to SNC Lavalin stressing their regular & active participation in the Committee's work and also pursue telephonically for submission of work done on the subject.

ITEM 10 ANY OTHER BUSINESS

10.1 The Committee decided to hold the next meeting in the month of October 2024.

ANNEX 1

(Item 7.1)

Comments received from HPPCL:

Sl. No.	**Name of the Organization**	**Clause**	**Type of Comment General /Technical/Editorial**	**Comments (Justification For Change)**	**Proposed Change**
1.	HPPCL	Clause 4.2.4 11639 part (2):1995	Technical	Para (c) states as, "Emergency condition includes partial gate closure in critical time of penstock (2L/a seconds) at maximum rate, and the cushioning stroke being inoperative in one unit". The above mentioned condition seems in order for considering of water hammer for single unit arrangement, however for arrangement having more than one units (in case of manifold) criteria for considering water hammer is not defined. However, 12967 Part (1) :1990 states under clause 6.1.2 (b) reaction turbine (iii) The water hammer shall be computed for maximum reservoir head condition for final part gate closure to zero gate position on one unit at the maximum governor rate of 2L/a seconds. Moreover, when closure of one unit is considered no emergency condition of operation arises as the velocity	CEA is requested to provide their views.

				of flow decreases considerably. Further, in IS : 4880 part (4):1971 (re-affirmed in 1995) the number of units is not mentioned.	
2.			Technic al	What percentage for partial gate opening shall be considered for computing water hammer under emergency condition.	CEA is requested to provide their views.
3.	HPPCL	Clause 4.2.4 11639 part (2): 1995	Technic al	The para reads “Emergency condition includes partial gate closure in critical time of penstock (2L/a seconds) at maximum rate, and the cushioning stroke being inoperative in one unit”. The above-mentioned condition seems to be in order for computing water hammer for single penstock feeding single unit. However, for arrangement having main penstock feeding more than one unit (in case of manifold/header) criterion for computing water hammer value is not documented/ well defined. Moreover, it has been linked with partial gate closure in critical time of penstock in IS 11639 part 2. The same however is linked with final part gate closure to zero gate closure in IS 12967 Part 1 under clause 6.1.2 (b). The moot question is how to compute partial gate closure in critical time of penstock. Furthermore, what inferences the designer must draw from the final part gate closure to zero gate closure in critical time	CEA is requested to provide their views.

				of penstock and how to compute it. There is no mention of number of units to be considered for computing water hammer value in critical time of penstock is IS 4880- Part (4): 1971. All these codes need to be integrated in order to avoid any controversy. As computation of water hammer value in critical time of penstock is linked with velocity of flow destroyed, in this critical time especially in penstocks which have this critical time of less than 1.0 sec.	
4.	HPPCL	-do-	-do-	In case of Francis turbine, the condition of instantaneous closure of guide vanes due to malfunctioning of governor can never be realized. Any malfunctioning of control systems would, instead of making these close instantaneously, would however, render the guide vanes in open position which shall mean that there is no any abnormal rise in water hammer value as envisaged during emergency condition.	CEA is requested to provide their views.

ANNEX 2

(Item 8)

COMMENTS RECEIVED ON IS 4880 Part 1 CODE OF PRACTICE FOR DESIGN OF TUNNELS CONVEYING WATER PART 1 GENERAL DESIGN FIRST REVISION

Sl. No.	Organization	Clause/ Subclause Paragraph Figure/ Table	Type of Comment General/ Technical / Editorial	Comments (Justification For Change)	Proposed Change	Decision of the Panel on 06 Sept 2023	Decision of Committee in the 23rd meeting
1.	NHPC Ltd.	Clause 2.2.1	Technical	Proposed change is as per the provisions in IS 17833:2002 (Geological exploration for Tunnels- Guidelines)	Preliminary investigations for aligning the tunnel should be carried out on available 1:50000 /**1:25000** scale Survey of India Topo Sheets. Once the general feasibility of the tunnel is	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.

					established, detailed strip topographic maps along the tunnel alignment should be prepared to a scale 1: 10 000/**1: 5000** with 5 m to **2m** contour interval.		
2.	-do-	Clause 2.3	-do-	In this clause, it is mentioned that geological investigation should be carried out with sophisticated instruments and some are listed in Clause 4.1. But, clause 4.1 defines instruments used during construction which is not coherent/compatible. Therefore, this clause may be rephrased with reference to IS 17833:2022. (Geological exploration for Tunnels- Guidelines)	Geological investigations should be carried out with **modern investigation methods in accordance with the provisions contained in IS 17883,** if the area has been aerially photographed, such data should be studied.	Panel members deliberated and agreed to incorporate the proposed change.	The Committee deliberated and decided to include the following: **'investigation methods in accordance with the provisions contained in IS 17883'**
3.	-do-	Clause 2.3.2 (c)	-do-	Mentioned clause may be rephrased with reference to IS 17833:2022. (Geological exploration for Tunnels-	Geophysical investigations — This type of investigation is helpful in establishing the rock-soil boundary, in	Panel members deliberated and agreed to incorporate the	The Committee deliberated and decided to include as

				Guidelines)	delineating fault and shear zones, other geological structures and similar phenomenon. **These investigations should precede exploratory drilling and drifting activities**. This investigation is also used in evaluating rock mass quality by determining in-situ modulus of elasticity	proposed change.	follows: **'Geophysical investigations should generally precede exploratory drilling and drifting activities**.'
4.	-do-	Clause 3.1	-do-	Since the provided laboratory tests determine Physico-mechanical properties; therefore, mechanical properties may be added along with physical properties.	The core samples collected from the bore holes shall be classified and specimen from each group shall be tested to determine the following physical and **mechanical** properties	Panel members deliberated and agreed to incorporate the proposed change.	The Committee deliberated and decided to modify the statement as follows: **'The core samples collected from the boreholes shall be classified and specimen from each group shall be tested**

							to determine the following properties’
5.	-do-	Clause 3.1 (f)	-do-	Shear strength parameters is measured by Direct Shear test and Triaxial shear test. Triaxial test is the most versatile test and used in all types of drainage conditions, whereas Direct shear test is quick, inexpensive and simple. Therefore Direct/Triaxial may be added to measure shear strength parameters.	Shear Strength (**Direct**/Triaxial)	Panel members deliberated and agreed to incorporate the proposed change.	The Committee did not agree with the change.
6.	-do-	Clause 3.1 (k)	-do-	Clause 3.1 refers physical and mechanical properties, therefore “test” may be removed.	Brittleness **index**	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
7.	-do-	Clause 3.1 (m)	-do-	Typographical error	**Siever’s** ‘J’ value	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.

8.	-do-	Clause 3.1 (n)	-do-	Clause 3.1 refers physical and mechanical properties, therefore "test" may be removed.	**Abrasivity Index**	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
9.	-do-	Clause 3.1 (o)	-do-	This test may be added. [as per IS 17833:2002 (Geological exploration for Tunnels- Guidelines)]	**Slake Durability**	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the decision of the panel as **Slake Durability Index**.
10.	-do-	Clause 3.1	General	--	Sequencing of laboratory test may be rectified.		Requested BIS to modify in accordance with drafting rules.
11.	-do-	Clause 3.2.1 (a)	Technical	Typographical error	In-situ rock characteristics like shear strength parameters (C and **ϕ**), compressive strength and deformation modulus preferably by Goodman Jack;	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
12.	-do-	Clause 4.1 (a)	-do-	Closure is recorded periodically in the tunnel wall and roof, therefore " Walls and roof" may be added in the given	*Closure Observations* — Tunnel closure **(walls and roof)** should be observed at random interval throughout	Panel members deliberated and agreed to incorporate the following change	The Committee deliberated and decided to modify the statement as

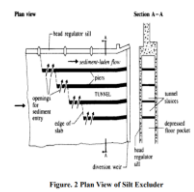
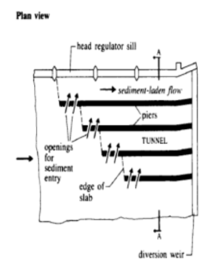
				statement of IS code. [Proposed change is as per the provisions in IS 17833:2002 (Geological exploration for Tunnels- Guidelines)]	the length of the tunnel.	*Closure Observations* — Tunnel closure **(walls and side's roof)** should be observed at…	follows: Closure /Convergence Observations — Tunnel closure **(walls and roof)** should be observed at…
13.	-do-	Clause 4.1 (f)	-do-	Convergence observation may be added for monitoring tunnel convergence.	***Convergence Observations-*** **Optical targets should be used for monitoring of tunnel convergence.**	Panel members deliberated and agreed to incorporate the following change. Convergence Observations- Optical targets should be preferred for monitoring of tunnel convergence.	Not agreed as already incorporated in S. No. 12.

ANNEX 3

(Item 8)

COMMENTS RECEIVED ON IS 13495 DESIGN OF SEDIMENT EXCLUDERS - GUIDELINES

Sl. No.	Organization	Clause/ Subclause Paragraph Figure/Table	Type of Comment General/ Technical/ Editorial	Comments (Justification For Change)	Proposed Change	The decision of the Panel in 3rd meeting on 6th Sept 2023	The decision of the Panel in 4th meeting on 30th Oct 2023	Decision in the 23rd meeting
1.	NHPC Ltd.	Clause 2	Technical	Updated IS code may be mentioned.	IS 1191 :2016 **(Reaffirmed 2021)**	Not agreed in view of drafting rules in IS 12 being followed in BIS.	--	Agreed with the panel.
2.	-do-	Clause 5.1	-do-	Typographical error	All possible river approach conditions are to be examined carefully while deciding the layout of	Panel members deliberated and agreed to incorporate the proposed change.	--	Agreed with the panel for the change.

					excluder tunnels.				
3.	-do-	Clause 5.1	-do-	Definition sketch may be added to understand the design approach. **Ref:** Design of Silt Excluder of New Khanki Barrage: A case study of Lower Chenab Canal, Pakistan- Hira Hameed, Ghulam Nabi Sci. Int (Lahore),27(6),6023-6031,2015	**"Fig 1: Layout of Sediment Excluder- Khanki Barrage"** may be added. 	Panel members deliberated and decided to incorporate the proposed figure after removing section A-A from the figure as shown below : 	Panel members deliberated and decided to incorporate the figure as decided in the last meeting with the title of the figure as Fig. 1 **Typical layout of sediment excluder** in a project	The committee deliberated and agreed for title of the figure as '**Typical layout of sediment excluder**'. The Committee decided to r**etain the section A-A, as included in initial proposal**.
4.	-do-	Clause 5.5.2	-do-	Typographical error	The velocity at the exit end of the tunnel may be worked out from the working head and throttling effected to attain velocity higher	Panel members deliberated and agreed to incorporate the proposed change.	--	Agreed with the panel for the change.

					than 3.0 to 3.5 m/s at the exit in alluvial reach and 4 to 5 **m/s** in shingles and cobbles reach.			
5.	-do-	Annex-A	-do-	Figure of Shield's Curve for critical tractive stress for determination of size of coarsest material may be added. **Ref**: 1. Mechanics of sediment transportation and alluvial stream problems- RJ Garde and KG Ranga Raju 2. Flume study of the effect of relative depth on the incipient motion of coarse	**"Fig 2: Shield's Curve for critical tractive stress (Condition for Incipient Motion) "** may be added.	Panel members deliberated and requested some time for reviewing the figure. Will be dicussed in next meeting.	The panel members deliberated and requested Prof. Z Ahmed to provide both diagrams as decided for inclusion in the draft along with the suitable modification in the clauses of the annexure.	More discussions are further required in working group on input received from Prof. Z. Ahmed. Panel meetings to be held soon and submit its recommendations accordingly. The Committee requested Dr. Nayan Sharma to submit his inputs regarding Reynolds stress approach to the panel.

				uniform sediments- Andrey B. Shvidchenko and Gareth Pender Published on WATER RESOURCES RESEARCH, VOL. 36, NO. 2, PAGES 619-628, FEBRUARY 2000 3. Critical Shields values in coarse-bedded steep streams- Kristin Bunte, Steven R. Abt, Kurt W. Swingle, Dan A. Cenderelli, and Johannes M. Schneider WATER RESOURCES RESEARCH, VOL. 49, 7427–7447, doi:10.1002/2012WR012672, 2013				

6.	CWPRS	Annex-A A-1 4	Technical	Typographical error	Assume some value of t_{ex} (t_{ex} = tunnel depth),		Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
7.	-do-	Annex-A A-1 16. Friction losses	-do-	Typographical error	$h_f = \frac{V_2^{\;2}\, L\, n^2}{r_{ex}^{\;4/3}}$		Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
8.	-do-	Annex-A A-1 2. Compute bed shear stress	-do-	Typographical error	$\tau = \Upsilon Ds \text{ or } \Upsilon rs$		Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
9.	-do-	Annex-A A-1 2.	-do-	Missing information	D = mean depth at flow (D = r for wide channels)		Panel members deliberated and agreed to incorporate the proposed	Agreed with the panel for the change.

		Where *D* = mean depth at flow,					change.	
10.	-do-	Annex-A A-1 3. d_g by shields or white criterion	-do-	Missing information	Shields or white is confusing. Shields method and Ackers and White theory are two different methods. (Ackers and White theory Report SR 237 April 1990 attached for reference) White should be removed.		Already covered in comment no. 5.	The Committee deliberated and requested Panel to submit their final view in conjunction with Item 5, which can be deliberated in the next meeting.
11.	-do-	Annex-A A-1 4.	-do-	Typographical error	$\frac{V_c}{\sqrt{\frac{\Delta \Upsilon_s}{\rho} d_s}} = 1.6 \left(\frac{r_{ex}}{d_s}\right)^{1/8}$		Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.

12.	-do-	Annex-A A-1 6. Select excluder velocity $V_{ex} > V_c = V_L$.	-do-	Missing information	V_L to be described		Panel members deliberated and did not agree to incorporate the proposed change as V_L has already been introduced in the code.	Agreed with panel recommendation. Change may not be incorporated.
13.	-do-	Annex-A A-1 9. for river width *b*,	-do-	Missing information	for river width *b is confusing as in notation b=* width of tunnel		Panel members deliberated and agreed to incorporate the proposed change	Replace river width 'b' with river width 'b_{re}'
14.	-do-	Annex-A A-1 10. sediment concentration	-do-	Missing information	C_{ex} to be included in Notations		Panel members deliberated and agreed to incorporate the proposed change	C_T is already defined as average concentration of sediment in percentage by weight. Same may be corrected in

		C_{ex}						Annex-A point 13. C in point 10 may also be changed to C_T.
15.	-do-	Annex-A A-1 11. sediment concentration C_{ex}	-do-	Missing information	C_{ex} to be included in Notations		Panel members deliberated and agreed to incorporate the proposed change	Observation same as point 14 above.
16.	-do-	Annex-A A-1 12.	-do-	Typographical error	r_{ex} d_s C_T (w = fall velocity of bed material of size (d_s) for specific weight of sand particle = 2.65.)		Panel members deliberated and agreed to incorporate the proposed change with modification in the specific weight as written below: 'Specific weight of sand	Agreed with the panel for the change.

							particle will be taken as per actual data (in absence of actual data, take 2.65).'	
17.	-do-	Annex-A A-1 13. $S_1 = 0.89d_s$	-do-	Typographical error	Value of $S_1 = 0.98d_s$ mentioned in notations (0.89 is correct value). and, b_{ex} t_{ex}		Panel members deliberated and agreed to incorporate the proposed change	The committee deliberated and Agreed as $S_1 = 0.89d_s$
18.	-do-	Notations;V = fall velocity of bed material of size d_s	-do-	Typographical error	V to be replaced with w		Panel members deliberated and agreed to incorporate the proposed change	Agreed with the panel for the change.

19.	-do-	Schematic diagram of sediment excluder to be appended to understand the layout.		Panel members deliberated and agreed to incorporate the proposed change	Observation same as point 3 above.
20.	-do-	In addition to above, there is a lot of grammatical mistakes in the main body of the code		Panel members deliberated and agreed to incorporate the proposed change	No observation brought out.

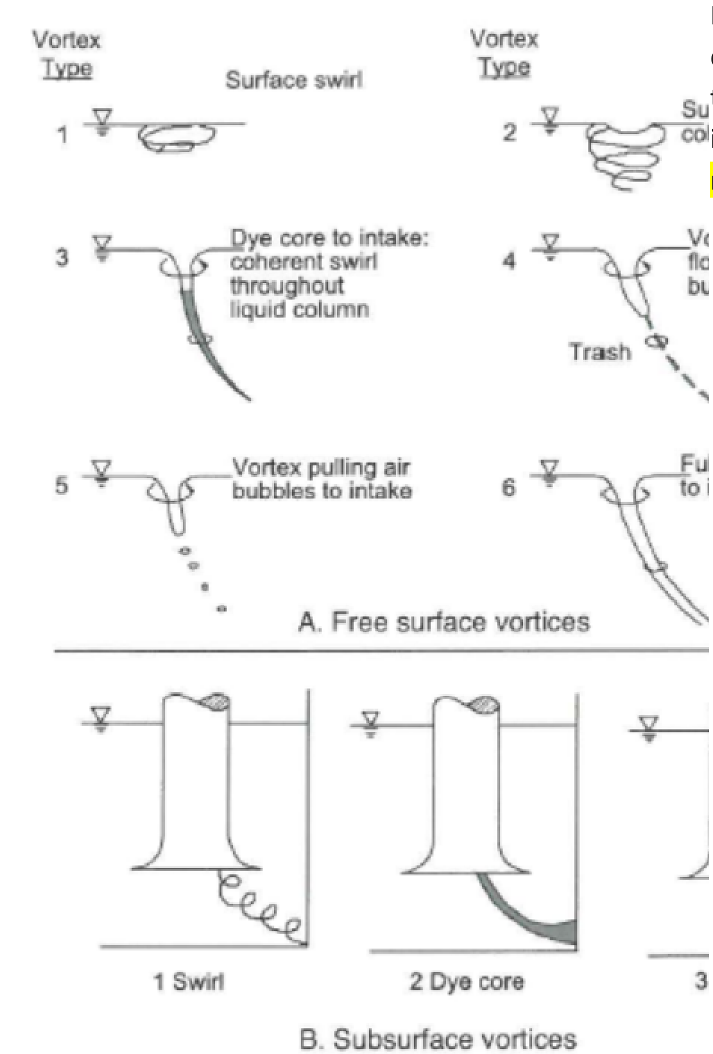
ANNEX 4

(ITEM 8)

COMMENTS RECEIVED ON IS 15310- HYDRAULIC DESIGN OF PUMP SUMPS AND INTAKES — GUIDELINES

SI. No.	**Committee/ Organization/ Individual**	**Clause / Subclause Paragraph Figure/ Table**	**Type of Comment General/ Technical/ Editorial**	**Comments (Justification For Change)**	**Proposed Change**	**Decision made in the 4th panel meeting held on 30.10.2023**	**Decision in the 23rd meeting**
1.	NHPC Ltd.	Foreword	General	Typographical error	Swirls and air entraining vortices affect pump performance……… damage, increased **suction** losses, and reduction in efficiency. ………. available net positive suction head **(NPSH)** of the pumps.	Panel members deliberated and agreed to incorporate the proposed change.	Change sought is already incorporated.
2.	-do-	Fig 2	-do-	Typographical	**VORTEX** CLASSIFICATION	Panel members deliberated and agreed	Change sought is already incorporated.

				error		to incorporate the proposed change.	
3.	-do-	Clause 2.11	-do-	Typographical error	Net positive suction head (NPSH) is the total inlet head plus the head corresponding to **the** atmospheric pressure, minus head corresponding to the vapor pressure	Panel members deliberated and agreed to incorporate the proposed change.	Change sought is already incorporated.
4.	-do-	Fig 5	Technical	Typographical error	$NPSH = H + \frac{P_O}{P_g} - \frac{P_V}{P_g} - h_t$	Panel members deliberated and agreed to incorporate the proposed change.	Agreed with the panel for the change.
5.	-do-	Clause 4.1	-do-	Typographical error	The following aspects shall be considered for a good **sump** design.	Panel members deliberated and agreed to incorporate the proposed change.	Corresponding clause is 4.0. Change sought is already incorporated.

6.	Prof. Z Ahmed, IIT Roorkee	Fig. 2	-do-	Deletion of old figure and insertion of new figure		Panel members deliberated and decided to discuss the comment in the next Committee meeting.	The Committee deliberated and requested Prof. Z Ahmed, IIT Roorkee to share definitions of all types of vortex given in the figure and requested the panel group to discuss and submit their final view.
7.	Prof. Z Ahmed, IIT	Item 5	-do-	Insertion of New clause 5	**5.0 Physical model studies of Pump Sump** **5.1 Need for a physical model study**	Panel members deliberated and decided to discuss the comment	The Committee noted that the inputs shared by Prof. Z Ahmed are

	Roorkee				A properly conducted physical model study is a reliable method to identify unacceptable flow patterns at the pump suction for given sump or suction piping design and to derive acceptable intake sump or piping designs. Considering the cost for a physical model study, an evaluation is needed to determine if one is required. A physical hydraulic model study shall be conducted for pump intakes with one or more of the following features: • A suction intake arrangement with elevation relative to water level that does not provide the minimum submergence requirement of this standard, irrespective of pump manufacturer's stated submergence values. • The intake design is not a standard intake design presented in this standard or the geometry (such as bay width, bell clearances, sidewall angles, bottom slopes, distance from obstructions, the bell diameter, submergence, or piping changes, etc.) deviates from this standard. • There is no prior physical model study for the intake design considered in terms of physical features and flow rates. • Non-uniform or non-symmetric approach flow to the pump sump exists (e.g., intake from a significant cross-flow, use of dual flow or drum screens; use of elbows, bends, or multiple screens just upstream of a trench-type wetwell;	in the next Committee meeting	very exhaustive and need to be streamlined for addition in the draft. The requirement of model study is already brought out in Cl. 5.0. Committee stressed that content in BIS code should be brief and not as detailed as in manual / guideline. Therefore, the Committee requested CWPRS to review the changes and submit their inputs to the panel group for discussion and finalisation.

					or a short-radius pipe bend near the pump suction, etc.). • Proper pump operation of a critical service or application as defined by the customer (such as a safety-related system). • Pump repair, remediation of a poor design, and the impacts of inadequate performance or pump failure all together would cost more than 10 times the cost of a physical model study. • Circular stations with four or more pumps. • For trench type wet wells (clear or solids-bearing liquids) the pumps have flows greater than 1260 L/s per pump or the total station flow with all pumps running would be greater than 3155 L/s. • Circular pump sumps (clear or solids-bearing liquids) with flows exceeding 315 L/s per pump require a physical model study. • The pumps of an open bottom barrel or riser arrangement with flows greater than 315 L/s per pump. • The pump of a closed bottom can intake has flows greater than 440 L/s. • The pumps have flows greater than 2520 L/s per pump or the total station flow with all pumps running would be greater than 6310 L/s. **5.2 Physical model study objectives** Adverse hydraulic conditions that can affect pump performance include free and subsurface vortices, swirl approaching the pump impeller, flow		

					separation at the pump bell, and a nonuniform axial velocity distribution at the suction. Free surface vortices are detrimental when their core is strong enough to cause a (localized) low pressure at the impeller and because a vortex core implies a rotating rather than a radial flow pattern. Subsurface vortices also have low core pressures and originate closer to the impeller. Strong vortex cores may induce fluctuating forces on the impeller and cavitation. Subsurface vortices with a dry-pit suction inlet are not of concern if the vortex core and the associated swirling flow dissipate well before reaching the pump suction flange. Pre-swirl in the flow entering the pump exists if a tangential component of velocity is present in addition to the axial component. Swirl alters the inlet velocity vector at the impeller vanes, resulting in undesired changes in pump performance characteristics, including potential vibration. A reasonably uniform axial velocity distribution in the suction flow (approaching the impeller) is assumed in the pump design, and nonuniformity of the axial velocity may cause uneven loading of the impeller and bearings. A properly conducted physical model study can be		

					used to derive remedial measures, if necessary, to alleviate these undesirable flow conditions due to the approach upstream from the pump impeller. The typical hydraulic model study is not intended to investigate flow patterns induced by the pump itself or the flow patterns within the pump. The objective of a model study is to ensure that the final sump or piping design generates favorable flow conditions at the inlet to the pump. **5.3 Physical model similitude and scale selection** Physical models involving a free surface are operated using Froude similarity because the flow process is controlled by gravity and inertial forces. The Froude number, representing the ratio of inertial to gravitational forces, can be defined for pump intakes as: $$F = \frac{u}{(gL)^{0.5}}$$ Where: u = average axial velocity (such as in the suction bell) g = gravitational acceleration		

					L = a characteristic length (usually bell diameter or submergence) In physically modeling a pump intake to study the potential formation of vortices, it is important to select a reasonably large geometric scale to minimize viscous and surface tension scale effects, and to reproduce the flow pattern in the vicinity of the intake. Also, the model shall be large enough to allow visual observations of flow patterns, accurate measurements of swirl and velocity distribution, and sufficient dimensional control. Realizing that larger models, though more accurate and reliable, are more expensive, a balancing of these factors is used in selecting a model scale. To ensure minimum scale effects, the model geometric scale shall be chosen so that the model bell entrance Reynolds number and Weber number at the pump rated flow are above 6×10^4 and 240, respectively, for the test conditions based on Froude similitude. For practicality in observing flow patterns and obtaining accurate measurements, the model scale shall yield a bay width of at least 300 mm, a minimum liquid depth of at least 150 mm, and a pump Throat or suction diameter of at least 80 mm		

					in the model. **5.4 Physical model study scope** Selection of the model boundary is extremely important for proper simulation of flow patterns at the pump. As the approach flow nonuniformities contribute significantly to the circulation causing pre-swirl and vortices, a sufficient area of the approach geometry or length of piping has to be modeled, including any channel or piping transitions, bends, bottom slope changes, control gates, expansions, and any significant cross-flow past the intake. All pertinent sump structures or piping features affecting the flow, such as screens and blockage due to their structural features, trash racks, dividing walls, columns, curtain walls, flow distributors, and piping transitions must be modeled. In modeling screens, the screen head loss in the model shall be the prototype screen head loss times the model scale ratio. The inside geometry of the bell (and hub, if modeled) up to the bell throat (section of maximum velocity) shall be scaled. Any vanes in the bell shall not be modeled. For free surface intakes, the model shall be deep enough to cover the range of scaled		

					submergence. **5.5 Swirl Measurement** Swirl in the suction pipe: The intensity of flow rotation shall be measured using a swirl meter, see Figure 1. The swirl meter shall consist of a straight-vaned propeller with four vanes mounted on a shaft with low-friction bearings. The tip-to-tip vane diameter is 75% of the pipe diameter and the vane length (in the flow direction) is equal to 0.6 pipe diameters. The location of the swirl meter should be about four suction pipe diameters downstream from the bell or pump suction flange to allow for convenient installation of velocity traverse instrumentation. The revolutions per unit time of the swirl meter are used to calculate a swirl angle, θ, which is indicative of the intensity of flow rotation. Swirl measurement angle $$\theta = \arctan\left(\frac{\pi d n}{u}\right)$$ Where: u = average axial velocity at the swirl meter d = diameter of the pipe at the swirl meter		

n = revolutions/second of the swirl meter

Swirl meter readings shall be obtained continuously; for example, readings during consecutive intervals of 30 seconds, covering a period of at least 10 minutes in the model. Swirl meter rotation direction shall also be noted for each short duration. The maximum short duration swirl angle and an average swirl angle shall be calculated from the swirl meter rotations.

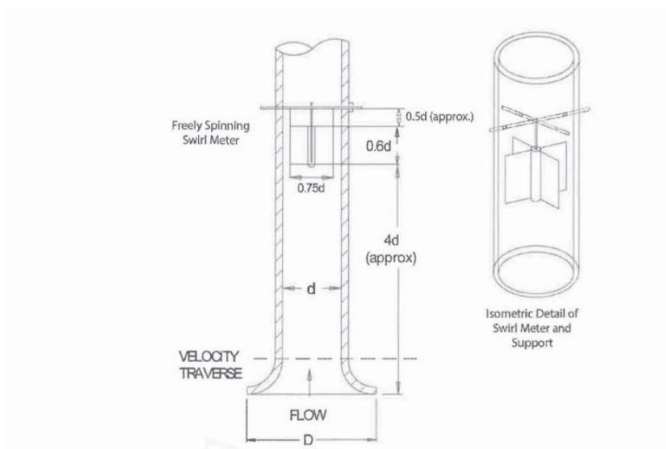


Figure 1 Typical swirl meter

5.6 Acceptance criteria

The acceptance criteria for the model test of the final design shall be the following:

- Free surface and subsurface vortices entering

					the pump must be less severe than vortices with coherent (dye) cores (free surface vortices of Type 3 and subsurface vortices of Type 2 in Figure 2). Dye core vortices may be acceptable only if they occur for less than 10% of the time or only for infrequent pump operating conditions. • Swirl angles, both the short-term (30-second model) maximum and the long-term (10-minute model) average indicated by the swirl meter rotation, must be less than 5 degrees. Maximum short-term (30-second model) swirl angles up to 7 degrees may be acceptable, only if they occur no more than 10% of the time or for infrequent pump operating conditions. The swirl meter rotation should be reasonably steady, with no abrupt changes in direction when rotating near the maximum allowable rate (angle). • Time-averaged velocities at points in the throat of the bell or at the pump suction in a piping system shall be within 10% of the cross-sectional area average velocity. Time-varying fluctuations at a point shall produce a standard deviation of less than 10% of the time averaged signal. • For the special case of pumps with double suction impellers, the distribution of flow at the pump suction flange shall provide equal flows to each side of the pump within 3% of the total pump flow.		