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**Office of the Chief Engineer (BODHI)**  
**Water Resources Department, Dam Safety Building**  
**Link Road No. 2, Tulsi Nagar, Bhopal, Bhopal 462 003,**

No.  
To,

/DS/NDSC/161/2015

Bhopal, dated /02/2017

1. Chief Engineer, Chambal Betwa Basin, Water Resources Department, Bhopal
2. Chief Engineer, Water Resources Department, Hosangabad
3. Chief Engineer, Narmada Tapti Basin, Water Resources Department, Indore
4. Chief Engineer, Yamuna Basin, Water Resources Department, Gwalior
5. Chief Engineer, Wainganga Basin, Water Resources Department, Seoni
6. Chief Engineer, Ganga Basin, Water Resources Department, Rewa
7. Chief Engineer, Dhasan Ken Basin, Water Resources Department, Rewa
8. Chief Engineer, Rahghat Canal Project, Datia
9. Chief Engineer, E/M, Water Resources Department, Bhopal

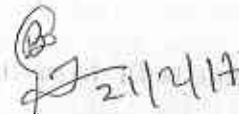
**Sub:- Dam Rehabilitation and Improvement Project - Recommendations of First and Second National Dam Safety Conference.**

**Ref:-** Chairman and Ex-Officio Secretary, Govt. of India, M/O WR, RD & GR letter no. DRIP/18/1/2016- DSRD/NDSC/2017 dated 13-12-2016.

Chairman and Ex-Officio Secretary, Govt. of India, M/O WR, RD & GR vide reference letter sent a recommendations of First and Second National Dam Safety Conference which was held on 24-25 March, 2015 and 12-13 January, 2016 respectively with the hope that these recommendations as appropriate in the interest of promoting Dam Safety in the state may be considered.

It is requested to direct the officials of your formation to follow these recommendations for dam safety. These recommendations along with compendium of technical papers are available on the website: [www.damsafety.in](http://www.damsafety.in).

Encl:- Reference letter with recommendations.

  
(Bharat Gosavi)  
Chief Engineer  
BODHI, WRD, Bhopal

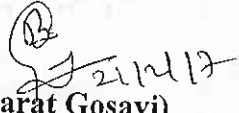
Bhopal, dated 27/02/2017

Endt. No. 142 /DS/NDSC/161/2015

Copy to:-

1. The Engineer in Chief, Water Resources Department, Govt. of MP, Bhopal, with reference to your office letter no. 2361084/82/DRIP/Part-2/2016, dated 23.01.2017.
2. Web Manager, Office of the Project Director, World Bank Projects (PICU), Water Resources Department for publication on Departmental web-site. Also keep these on Sub Folder of DRIP which is under folder Major Projects, Medium Projects and Minor Projects.

Encl:- Reference letter with recommendations.

  
(Bharat Gosavi)  
Chief Engineer  
BODHI, WRD, Bhopal

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जी. एस. झा  
G. S. JHA

अध्यक्ष  
एवं पदेन सचिव, भारत सरकार  
Chairman  
& Ex-Officio Secretary to the Govt. of India



सत्यमेव जयते

भारत सरकार  
केन्द्रीय जल आयोग  
जल संसाधन, नदी विकास  
और गंगा संरक्षण मंत्रालय  
कमरा न० 315 (द), सेवा भवन  
आर. के. पुरम, नई दिल्ली-110006  
Government of India  
Central Water Commission  
Ministry of Water Resources,  
River Development and Ganga Rejuvenation  
Room No. 315 (S), Sewa Bhawan  
R. K. Puram, New Delhi-110006  
Date: 13 December, 2016

05  
16-01-17

33/E-III-C  
10/01/2017

Ref: DRIP/18/1/2016-DSRD/NDSC/2017/

Dear Shri Kapoor,

The Central Water Commission (CWC) is coordinating implementation of the Dam Rehabilitation and Improvement Project (DRIP), with financial assistance from the World Bank, to rehabilitate about 250 large dams in seven states. As part of its institutional capacity building initiative CWC is taking the lead in organizing National Dam Safety Conferences in different states as yearly events. These conferences promote the concepts, techniques, instruments, and materials for design and construction of new dams, as well as for monitoring operation, maintenance and rehabilitation of existing dams. They provide an opportunity for dam professionals and organizations to share their knowledge and experience as well as their technologies, innovations, and dam safety initiatives.

CWC joined hands with Tamil Nadu Water Resources Department and Indian Institute of Technology, Madras for the First National Dam Safety Conference, which was held in Chennai in March 2015. The Second National Dam Safety Conference took place in Bengaluru in January 2016, where CWC collaborated with the Karnataka Water Resources Department and the Indian Institute of Science, Bengaluru.

The profile of the delegates participating in the conferences included policy and decision makers in the management of large dams in India and engineers, hydrologists, geologists, dam owners / operators, industry representatives, academic and research institutes and other stakeholders both within and outside the country. Based on the technical papers presented by the dam professionals, and the deliberations that took place afterwards, recommendations for improving the dam safety in India were adopted in the conferences. I am glad to attach the recommendations adopted at these conferences for your kind information; these recommendations along with a compendium of technical papers are available on our official website: [www.damsafety.in](http://www.damsafety.in).

You may consider issuing a suitable direction to concerned agencies for implementing these recommendations as appropriate in the interest of promoting dam safety in your State.

Looking forward for a positive response on this matter.

with the regards  
10 JAN 2017

Sincerely yours

*G.S. JHA*  
(G.S. JHA)

30/12  
(पंकज अग्रवाल)  
मुख्य सचिव, जल संसाधन  
CC: P.A. to S. JHA

Shri Tilak Raj Kapoor  
Secretary  
Water Resources Department,  
Narmada Bhawan, Tulsi Nagar,  
Bhopal - 462003  
MADHYA PRADESH

C.E. (I.S.)		S.E. (A)
C.E. (N.M.)		C.P.O.
C.E. (P)		E.E. (V)
S.E. (Major)		E.E. (R)
S.E. (W)	Sr. P.A.	S.A. (EDP)

SE(M)  
D. G. ...  
as per (A)  
10/1/17

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Recommendations based on the deliberations during the  
First National Conference on Dam Safety, 24-25 March 2015

**TS-I: Design Flood Estimation and Dam safety Measures for Flood Mitigations**

- i. For dams with small catchment areas, storms having less than 24 hours duration may be critical and should be adopted while assessing their design flood. It would be worthwhile to adopt multiple storm durations to produce multiple inflow design flood hydrographs to arrive at the most severe inflow design flood hydrograph.
- ii. Frequency of extreme events has been seen to be increasing in the South Indian peninsula. More extensive data needs to be analyzed for establishing the reasons for significant increasing trends in rainfall in this region. The impact of the likely increase in extreme hydro-meteorological events on river valley projects should be addressed.
- iii. The Probable Maximum Precipitation (PMP) atlases form a comprehensive knowledge bank which provide not only readily useable SPS/PMP estimates at sub basin level/ grid points but also detailed data of around 700 storms for carrying out project/ catchment specific SPS/PMP studies. Use of revised PMS atlas for design flood reviews are recommended.
- iv. In case of blockage of rivers due to a major landslide, the information pertaining to possible additional rise in river water level and warning time in the event of possible dam breach is very important input for disaster management planning. The river cross sections and other data along with breach modelling framework may be kept ready so as to provide requisite information to concerned authorities at the shortest possible time.
- v. While carrying breach analysis of blockage of river due to land slide or any other reason, the assessment of sediment volume likely to be generated during the event should also be taken care of.
- vi. As hydrology is a dynamic process, the hydrological parameters such as design flood, should be reviewed periodically, particularly when a significant hydro-meteorological event occurs in the catchment of the project.
- vii. Impact on design flood due to cloud burst and GLOF needs to be analyzed and incorporated in the practice.

**TS-II: Risk assessment and emergency preparedness**

- The conference recommends that the efforts to ensure 'fail safe' dam structures shall be made with a timely release of the funds required for the purpose.
- Institutional capacities of dam owning organizations as well as premier academic institutes shall be improved to develop emergency action plans for every large dam in the country and keep them updated.
- The soundness and stability of dam abutments needs to be thoroughly investigated and suitably featured in the dam design for mitigation of risks associated with abutment failures.

**TS-III: Institutional arrangements and good management practices for sustainable dam safety**

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- Dam safety organizations in every state and other dam owning authorities shall be strengthened with adequate and qualified manpower.
- Development of information system for monitoring the status of dam health and long term data backup shall be taken up as priority.
- Quality control set up for monitoring the quality of works during construction of new dams or during dam rehabilitation shall be strengthened in each state.
- DRIP can provide the necessary initiative for a three-way collaboration involving experts in technical organizations, dam owners and academic and research institutions for effective implementation of new technologies in dam safety.
- A suitable workflow process for dam rehabilitation works, similar to DRIP mechanism, needs to be replicated by non DRIP states.

**TS-IV: Latest Innovations and Methods for Monitoring Dam Health**

- State-of-art tools have become available at affordable costs for real time, automated monitoring of dam behaviour. The dam owners are advised to make maximum use of these technologies for ensuring the health and safety of their dams.
- Pollution of dam reservoirs can have significant impact on the health of dams and hence preventive measures are needed to check the entering of pollutants in dam reservoirs.
- Dam instrumentation is also vital for establishing the prevalent design philosophies so as to improve upon them. All new dam constructions shall be encouraged to incorporate such instrumentation preferably in collaboration with premier academic and research institutes.

**TS-V: New Materials and Methods for Dam Rehabilitation**

- Existing techniques of dam rehabilitation based on grouts, guniting, etc. may not be effective in all cases. New techniques based on geomembranes, micro-fine cements, fibre reinforced concrete and other chemical based grouts shall be adopted based on sound engineering judgement.
- Wherever appropriate, new materials and technologies shall be encouraged in a select few dams so as to derive confidence on their performance, and also to scale up their usage for financial viability of such new techniques.

**TS-VI: Compliance with the Provisions of Design Standards – Issues & Strategies for Existing Dams**

- Periodic maintenance and adherence to codal requirements in dam construction is important.
- The relaxation of codal stipulations for rehabilitation of dams needs to be examined case-to-case based on the site conditions, hazard potential and techno-economics.
- The effect of alkali-silica slow reaction (ASSR) for dam rehabilitation works needs to be validated through more field data. The phenomenon of Delayed Ettringite Formation (DEF) and its impact on dam concrete swelling needs to be investigated on ageing concrete dams.



## Second National Dam Safety Conference

12 - 13 January 2016 JN Tata Auditorium, IISc, Bengaluru

Organized by CWC, KaWRD and IISc

Website: [www.damsafety.in](http://www.damsafety.in)

### RECOMMENDATIONS

The Second National Dam Safety Conference was organized during 12-13, January 2016 at IISc, Bengaluru. The deliberations were held on 6 different themes spanning over 9 technical sessions. The Conference also had one Open Session dealing with the topic 'Need for DRIP like programmes for sustaining Dam Safety Initiatives across India'. The sessions were highly interactive and informative. The following recommendations have emerged during the deliberations at the Conference:

#### **TS-1: Design flood estimation and methodology for ensuring hydrological and hydraulic safety of Dams**

- The hydro-meteorological approach is an acceptable method for assessment of PMF for projects. Detailed analysis would help the professionals in understanding the required studies in a systematic manner.
- There is urgent need for assessing the impact of climate change on PMF to be used for taking appropriate dam safety measures in the country
- Sensitivity analysis for dam breach parameters should be carried out while carrying out dam break analysis
- The downscaling of GCM to local scale for Indian conditions need to be studied in details keeping in view the requirement of dam safety studies as also for proper management of water resources, however its application for extreme events should be used cautiously.
- Volume and duration of flood events should also be considered along with the peak discharge rates using multivariate modelling to assess the risk of flood events in its entirety.

#### **TS-2: Extent and Methodology for site investigations for the health and safety of dams**

- Investigations for assessment of health status of existing dams are important for their safety.
- Structural safety of the dams is required to be assessed at regular intervals to know the health status and taking up remedial measures for keeping them structurally safe and fit for their intended use.
- State-of-the-art tools are available for assessment of health status of dams. These tools are cost effective and quick to deliver results. Dam owners are advised to use latest available technologies such as geophysical methods, modern dam instrumentation etc. for ensuring health and safety of dams.
- Periodic and systematic maintenance of dams is important to ensure their sound health and safety:



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### TS-3: Planning and design considerations for safe dam

- Reservoir operating condition corresponding to Flood Reservoir Level (FRL) in non-monsoon, between FRL and Minimum Draw Down Level (MDDL) in monsoon and one or two flushing every year could be the better option for the sediment management as well as optimal power generation aspect for the river valley projects in Himalayas.
- Catchment area treatment and construction of check dams in upper river reaches in general may be helpful in better silt management.
- Deformation measurement by conventional Electronic Distance Measurement (EDM) has some limitations in fixing measuring points, prompt measurement in emergency. This has been overcome by Global Positioning System (GPS) method, with high precision which reveals behaviour of dams which were previously undetectable with existing methods.
- The heterogeneity of foundation has to be considered during the Finite Element Method (FEM) analysis of dam using concept of fracture mechanics.
- Proper co-ordination among the designers, fabricators, erection personnel/agencies, stringent quality control/checks at each stage of erection/fabrication of hydro mechanical equipment should be adhered to.

### TS-4: Challenges in Dam Health Monitoring and Mitigation of Dam Health Issues

- The flexible geo-membrane can effectively be used in waterproofing of dams both in dry condition and under water.
- There is a need to strengthen the Institutional set up of Dam Safety Organisations.
- Proper planning and investigation coupled with quality control during construction stage are key to avoid havoc later and to perform the intended purpose of any water resources development project.
- The development of vulnerability index methodology for dams considering associated risk factors and dependence of society on the dam would be very useful in prioritizing the desired remedial measures for the safety of the dam.
- ~~There is a need to enhance the value of existing dams by harnessing additional possible benefits. Vast area available in dams can be utilized for harnessing solar power.~~

### TS-5: Innovations and integration of technologies for dam safety

- The open source numerical models such as WFlow, RTC-Tools & Delft-FEWS have the capability for short-term operational inflow forecasting which can be used for decision support system for reservoir operations.
- The Hedge Management Model (HMM) for reservoir operation and management with the objective for minimising the impact of different accruing water demands will have



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greater efficacy than Standard Operating Procedure (SOP) when water stress exists and future reservoir inflow is more uncertain.

- The instrumentation and remote control system for gate operation has many applications. However the cost aspects and efficiency needs to be verified.
- The advancement in instrumentation of dams and new technologies which are proposed for Idukki dam has applications for other dams which are to be rehabilitated.
- The concrete injection technologies for treatment of leakages, abrasions etc. in old dams have practical significance. However, the comparison with similar products with regard to cost, durability, equipment for application etc. needs to be considered while selecting such products.
- Dredging systems should be environment friendly.

**TS-6: Quality Control & Quality Assurance**

- Quality control and quality assurance as a measure in totality and is required to be carried out from design stage to procurement and construction stage till commissioning of the project.
- The particular aspects to be focused will vary for new construction projects as opposed to that of rehabilitation project.
- Inadequate Quality Control & Quality Assurance during the active period of construction / rehabilitation may put the entire work in jeopardy. Hence a strict vigilance throughout the project period is the recommended solution.
- Quality Management System shall be introduced in the State Dam safety Organisations across the country.

**Open Session: Need for DRIP like programmes for sustaining Dam Safety Initiatives across India**

- Even though there is considerable attention towards improvement of the distribution network for better management of surface runoff water through 'Extension, Renovation and Modernisation (ERM)' projects under 'Accelerated Irrigation Benefits Programme (AIBP)', the issues of dam performance and health are not receiving adequate attention and largely, the dams are being neglected; there is need to sensitise the decision makers on the issue.
- For building climate change resilience, consistent operational and storage policies shall be adopted to provide assurance of a safe and consistent dam behaviour from structural and flood point of view.
- There is a need to implement the dam safety programme in a systematic and sustained manner with emphasis on providing adequate technical and managerial advice to the dam owners and also providing funding through different means.



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- Many issues of dam safety and operation will come up due to changes in downstream flood plain developments as well as interventions that may happen on the upstream catchment areas. There is also lack of awareness in the engineering and scientific community for capacity building in the field of flood and other hazard assessment as well as the understanding of the material behaviour and deterioration phenomena. Such issues need to be resolved through the nationwide dam safety assurance programme.
- The DRIP programme has been successful in bringing about greater awareness on dam safety and it has provided a great opportunity for introducing new solutions and technologies in dam management and rehabilitation. However, there are large areas of various basins which are not benefitting from the DRIP programme. Therefore, it is essential that the programme is uniformly adopted across all basins.
- Adoption of Dam Safety Legislation and consequent establishment of a uniform hazard assessment and mitigation regime will be greatly helped if the same is also supported by a national programme like DRIP for all such states who adopt the Legislation.

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