ICS 27.140
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NB

ENERGY INDUSTRY STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

NB/T 35092-2017

Design code for temperature control of concrete dam

混凝土坝温度控制设计规范

Issued on: March 28, 2017 **Implemented on: August 1, 2017**

Issued by: National Energy Administration of the PRC

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Foreword

This document was issued on 28 March 2017 by the National Energy Administration of the PRC and takes effect on 1 August 2017.

It is a NB/T standard: recommended rather than compulsory, but it is the text a Chinese reviewer applies when assessing a submission.

It is classified under ICS 27.140, Chinese classification P 59.

NB/T 35092-2017, Design code for temperature control of concrete dam, is an energy industry standard of the People's Republic of China. It was issued on 28 March 2017 by the National Energy Administration and took effect on 1 August 2017.

The Chinese title of the document is Hunningtu Ba Wendu Kongzhi Sheji Guifan (????????????). The English title printed on the cover of the standard is Design code for temperature control of concrete dam, and it matches the Chinese title clause by clause: it is a design code (????) for the temperature control (????) of concrete dams (????).

The cover carries the classification data of the document: ICS 27.140, which is the international class for hydraulic energy engineering, and the Chinese Standard Classification code P 59, which places the document among hydraulic and hydropower engineering standards. The record number of the standard is J2346-2017.

The document is a NB/T standard: recommended rather than compulsory in the strict legal sense, but it is the text a Chinese design reviewer applies when assessing the temperature control design of a concrete dam, and contract specifications routinely make it binding.

The department in charge of drafting is the China Renewable Energy Engineering Institute (??????????). The approving department is the National Energy Administration (?????). The date of implementation printed on the title page is 1 August 2017. The standard is published by China Electric Power Press, Beijing, 2017.

The cover carries no replacement note, so the document does not supersede an earlier edition. It is the first unified industry code addressing temperature control design for concrete dams: before it, the principles, contents, methods and technical requirements of that design were not covered by a single standard in the hydropower sector.

The document is organised in fifteen chapters. Chapters 1 and 2 give the general provisions and the terms; chapters 3 and 4 cover raw materials and concrete mix design; chapter 5 collects the design data and calculating parameters; chapter 6 covers the calculation of the temperature field; chapter 7 covers the jointspacing of the dam and the joint grouting temperature.

The later chapters carry the design of the temperature control measures proper, the temperature control of concrete in particular parts of the dam, the requirements placed on construction, and the monitoring and analysis of temperature during the construction period, which is chapter 15.

The standard is accompanied by an Explanation of provisions (????), a substantial companion section that restates each clause and gives the engineering reasoning, the test data and the project experience behind it. Several of the passages reproduced in this listing come from that section, and they are identified as such.

The document is written for concrete dams in hydropower projects. The dam height classes used throughout follow the two design codes cited in the explanation of clause 1.0.2: a dam lower than 50 m is a low dam, a dam between 50 m and 100 m is a medium dam, and a dam higher than 100 m is a high dam.

1 Scope

NB/T 35092-2017 is the Chinese design code for temperature control of concrete dams. It exists because of a problem peculiar to mass concrete: cement generates heat as it hydrates, and in a structure tens of metres thick that heat cannot escape. The interior of a freshly placed block rises tens of degrees above ambient over the following days, then cools slowly over months and years towards the stable temperature of the site. As it cools it wants to contract, and the surrounding rock and the already-hardened concrete below will not let it. The result is tension, and if the tension exceeds the tensile strength the dam cracks - not superficially but through the section, giving water a path through the structure and compromising the very thing the dam is for. Temperature control is therefore not a construction convenience but a design requirement, and it is designed before the first pour. This code sets out how. It covers the thermal properties of the concrete and the boundary conditions, the calculation of temperature fields and of the resulting thermal stresses, and then the control criteria themselves: the allowable foundation temperature difference within the restraint zone, the allowable internal and surface temperature differences, and the permissible rate of cooling. Around those it sets the measures used to meet them - the choice of cement and of mineral admixture to reduce the heat of hydration, precooling of the aggregate and of the mix water, the height and timing of lifts and the interval between them, embedded pipe cooling with its water temperature and flow rules, and surface insulation against cold waves - together with the joint spacing of the dam, the monitoring of temperature during construction, and the treatment of the situation when the criteria are exceeded. It was issued on 28 March 2017 by the National Energy Administration and took effect on 1 August 2017.

Chapter 1, General provisions, opens the standard at page 1 and sets out the purpose, the field of application and the relationship of this code with the other standards of the sector.

The explanation of clause 1.0.1 states the reason the code was written: the temperature control design of concrete is an important component of the design of a concrete dam, and at the time of drafting the hydropower industry had no unified standard laying down the principles, the contents, the methods and the technical requirements of that design. Preparing this code was therefore held to be of significant guiding value for the construction of hydropower projects.

The explanation of clause 1.0.2 defines the field of application through the dam height classes already fixed by two companion codes. The Design code for concrete gravity dams NB/T 35026 and the Design code for concrete arch dams DL/T 5346 provide that a dam height below 50 m is a low dam, a dam height from 50 m to 100 m is a medium dam, and a dam height above 100 m is a high dam.

That classification matters because the temperature control requirements of the code are graded: the taller the dam and the stronger the foundation restraint, the tighter the allowable

temperature difference and the more elaborate the cooling arrangement that the design has to provide.

The general provisions establish that temperature control design is not an accessory to the structural design of the dam but part of it, to be carried through from the selection of the raw materials to the monitoring of the concrete during construction.

The chapter also positions the code within the hierarchy of Chinese hydraulic standards: where a subject is already covered by a specific code, such as concrete construction or the quality control of concrete, that code continues to apply and this one adds the temperature control requirements.

The general provisions are the shortest chapter of the standard, occupying page 1, but they govern the reading of everything that follows, in particular the distinction between requirements that apply to all dams and requirements that apply only above a stated dam height.

Chapter 2, Terms, follows at page 2 and gives the vocabulary used in the rest of the document.

2 Terms

Chapter 2 collects the terms of the code and their definitions, and runs from page 2 to page 4 of the standard.

The vocabulary of the chapter is the vocabulary used consistently in the following chapters: the steady, quasi-steady and transient temperature fields, the border temperature, the jointspacing of the dam, the joint grouting temperature, and the classes of concrete distinguished by placing method and by position in the dam body.

Because the code is applied together with the concrete construction standards of the sector, the terms of chapter 2 are drafted to be consistent with those used in the Hydraulic concrete construction specification DL/T 5144 and in the Roller compacted concrete construction specification for hydraulic structures DL/T 5112.

3 Selection of concrete raw materials

Chapter 3 runs from page 4 to page 6 and covers the selection of the raw materials of the concrete, in four clauses.

Clause 3.1, Cement, at page 4, covers the choice of the cement type and the properties that matter for temperature control, in particular the heat of hydration.

Clause 3.2, Admixture, at page 4, covers the mineral admixtures, of which fly ash is the one that recurs throughout the worked examples of the standard.

Clause 3.3, Aggregate, at page 5, covers the aggregate. The statistics reproduced in the