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NB/T 10143-2019

Technical Code for Rockburst Risk Assessment of Hydropower Projects

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Foreword

This document was issued on 4 June 2019 by the National Energy Administration of the PRC and takes effect on 1 October 2019.

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 P59.

In accordance with the requirements of the Notice of the National Energy Administration on Issuing the 2015 Plan for the Formulation (Revision) of Industry Standards in the Energy Sector (Guo Neng Ke Ji [2015] No. 283), the drafting group of this code has formulated this code through extensive investigation and research, careful summarization of practical experience and wide solicitation of opinions.

The main technical contents of this code are: basic requirements, data collection and field investigation, rockburst risk evaluation, rockburst monitoring and warning, rockburst risk prevention and control, and the assessment report.

The National Energy Administration is in charge of the administration of this code. China Renewable Energy Engineering Institute proposed this code and is responsible for its routine management, and Nengyuan Hangye Shuidian Kance Sheji Biaozhunhua Jishu Weiyuanhui is responsible for the explanation of its specific technical contents. Comments and suggestions arising during implementation should be sent to China Renewable Energy Engineering Institute (address: No. 2 Liupukang Beixiaojie, Xicheng District, Beijing; postcode: 100120).

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1 Scope

NB/T 10143-2019 is the Chinese technical code for assessing rockburst risk in the underground excavations of hydropower projects. A rockburst is the sudden, violent failure of hard brittle rock around an opening under high stress: slabs and blocks are ejected from the wall or crown with enough energy to kill workers and destroy a tunnel boring machine. The deep headrace tunnels and large caverns of western China's hydropower schemes run

under rock cover of a kilometre or more, and rockburst is among the principal hazards of their construction. The code sets the general provisions, the defined terms and symbols, and the basic requirements, including the classification of rockburst intensity into grades with their descriptive criteria. It then covers data collection and site investigation - geology, in-situ stress measurement, rock mechanical properties and brittleness indices - and the assessment of rockburst risk at the design stage, combining the prediction of probability from stress and strength criteria with the evaluation of consequence to arrive at a risk level. Assessment during construction follows, updating the prediction as the face advances from observed conditions and from microseismic monitoring, with the arrangement of sensors, the analysis of events and the thresholds for early warning. Prevention and control measures - excavation method and sequence, stress relief, support with energy-absorbing bolts and mesh, and operational controls - and the content of the assessment report close the code.

1.0.1 This code is formulated with a view to standardizing the rockburst risk assessment work of hydropower projects.

1.0.2 This code is applicable to rockburst risk assessment at all stages of investigation and design and of construction of hydropower projects.

1.0.3 In addition to this code, the rockburst risk assessment of hydropower projects shall also comply with the relevant current standards of the nation.

2 Terms and Symbols

2.1.1 rockburst: dynamic phenomenon in which the elastic deformation potential energy accumulated in rock mass under deep or high tectonic stress is suddenly released under excavation or other external disturbance, causing bursting and ejection of the surrounding rock.

2.1.2 rockburst risk evaluation: process of analysing the possible location and intensity of rockburst, the rockburst loss grade and the rockburst risk grade.

2.1.3 rockburst intensity: index describing the violence of a rockburst and the scale of the damage it causes.

2.1.4 rockburst risk rating: classification criteria describing the degree of harm of rockburst hazards to the project and their level of risk.

2.1.5 ratio of strength to in-situ stress: ratio of the saturated uniaxial compressive strength of the rock to the maximum principal stress of the initial stress field.

2.1.6 microseismic monitoring: monitoring technique that uses dedicated microseismic equipment to collect, in real time, the vibration data generated by rock mass fracturing.

2.1.7 rockburst warning: prediction of the location of a potential rockburst together with its

rockburst intensity and probability of occurrence.

2.1.8 rockburst risk prevention and control: prevention and control measures to avoid the occurrence of rockburst or to reduce the intensity of rockburst, as well as measures for the protection of personnel and equipment.

D_f - depth of the rockburst pit.

ERR - energy release rate.

H_cr - critical burial depth, i.e. the minimum burial depth at which rockburst occurs.

LERR - local energy release rate.

P_i^mr - probability of rockburst occurrence.

RVI - empirical index of rockburst proneness.

U_imax - peak value of the elastic strain energy density of the i-th element before brittle failure.

U_imin - valley value of the elastic strain energy density of the i-th element after brittle failure.

W_et - elastic strain energy index.

W_r - energy released by the surrounding rock in a given dynamic excavation step.

3 Basic Requirements

3.0.1 Rockburst risk assessment shall mainly include rockburst data collection and field investigation, rockburst risk identification, rockburst risk evaluation, rockburst monitoring and warning, and rockburst risk prevention and control.

3.0.2 Rockburst risk identification for underground caverns shall simultaneously take into account factors such as rock strength, rock mass integrity and in-situ stress conditions; rockburst risk assessment shall be carried out when the following conditions are met:

3.0.2 item 1: the rock is moderately hard to hard, and the integrity of the rock mass is relatively good to good.

3.0.2 item 2: the ratio of strength to in-situ stress is not greater than 7, or the burial depth is greater than the critical burial depth.

3.0.3 Rockburst risk assessment shall include the classification of the rockburst risk grade, and the rockburst risk grade shall be determined according to the rockburst intensity and the rockburst loss grade.

3.0.4 The rockburst intensity (rockburst intensity grade) shall be determined according to the results of rockburst risk evaluation or rockburst warning. Rockburst intensity shall be