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NB

**ENERGY INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

NB/T 11553-2024

**Technical specification for observation of surface movement
and deformation in coal mines**

煤矿地表移动观测与数据处理技术规范

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Table of Contents

Foreword	3
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviations	1
4 General requirements	2
5 Purpose and work content of surface movement observation	2
6 Data collection and site investigation	3
7 Design of the surface movement observation station	4
8 Surface movement observation	8
9 Processing of the observation data	11
10 Other observation techniques	14
11 Observation results	18
Annex A (Informative) Reference material for the design of the observation station	19
Annex B (Normative) Formulae for calculating the survey error	21
Annex C (Normative) Electromagnetic distance measurement height traverse survey	23
Annex D (Normative) Formulae for calculating the surface movement and deformation of the observation station	25
Annex E (Normative) Calculation of the angular parameters of strata and surface movement	30
Annex F (Normative) Calculation of the surface prediction parameters	33
Annex G (Normative) Data processing workflow and requirements of some InSAR survey techniques	34
Bibliography	41

Foreword

This document was issued on 24 May 2024 by the National Energy Administration of the PRC and takes effect on 24 November 2024.

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 73.040, Chinese classification D 04.

This document was drafted in accordance with the rules given in GB/T 1.1-2020 Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents.

Please note that some of the content of this document may be the subject of patent rights. The issuing body of this document assumes no responsibility for identifying patents.

This document was proposed by, and is under the administration of, the coal standardization technical committee of the energy industry.

1 Scope

NB/T 11553-2024 is the Chinese specification for measuring how the ground surface moves above an underground coal mine, and for processing the measurements. It exists because extracting a coal seam removes support from everything above it, and the roof caves progressively upward until the movement reaches the surface as a subsidence basin - a broad dish of settlement, tilt, curvature and horizontal strain that can appear months after the face has passed and that reaches well beyond the edge of the panel. What sits inside that basin is not the mine's property: villages, farmland, roads, railways, pipelines and rivers. The angular parameters that predict where the basin edge will fall, and how much strain a building at that edge will experience, are the numbers on which compensation, protective pillar design and the decision whether to mine at all are based, and they can only be obtained by measuring real subsidence over real workings. This document standardises that measurement. It sets the general requirement that a new mine, or a producing mine whose geological and mining conditions have changed, must establish a surface movement observation station, and that important protected objects within the mine field must be observed. It covers the purpose and work content, the data collection and site investigation, the design of the observation station, the observation itself - connect survey, comprehensive observation before movement and after stabilisation, and daily observation in between - the processing of the data, and the presentation of results. A separate clause covers the modern techniques that have displaced pure levelling: GNSS and CORS-RTK, three dimensional laser scanning from the ground, from vehicles and airborne, low-altitude UAV photogrammetry, and above all satellite radar interferometry, with the whole family of InSAR methods named and defined - D-InSAR, PS-InSAR, SBAS-InSAR, DS-InSAR, CR-InSAR, CPT-InSAR, TCP-InSAR and TS-InSAR. Seven annexes carry the mathematics: the survey error formulae, the electromagnetic distance height traverse, the formulae for computing movement and deformation at the station, the calculation of the angular parameters of strata and surface movement, the calculation of the surface prediction parameters, and the data processing workflow and requirements for the InSAR techniques. It was issued on 24 May 2024 by the National Energy Administration and took effect on 24 November 2024.

This document specifies the general requirements for the observation of surface movement and the processing of the data in underground coal mines, together with the purpose and work content of surface movement observation, the data collection and site investigation, the design of the surface movement observation station, the surface movement observation

itself, the processing of the observation data, the other observation techniques and the observation results.

This document applies to the observation of surface movement and the processing of the data in underground coal mines.

2 Normative references

The contents of the following documents constitute indispensable provisions of this document through normative reference in the text. For dated references, only the edition corresponding to that date applies to this document. For undated references, the latest edition, including all amendments, applies to this document.

GB/T 12898-2009 Specifications for the third and fourth order levelling

GB/T 16818-2008 Specifications for medium and short range electro-optical distance measurement

GB/T 17942 Specifications for national triangulation

GB/T 18314-2024 Specifications for global navigation satellite system (GNSS) surveys

GB 50026-2020 Code for engineering surveying

CH/Z 3017 Technical specification for terrestrial three dimensional laser scanning

3 Terms, definitions and abbreviations

3.1 Terms and definitions

The following terms and definitions apply to this document.

3.1.1 observation station of surface movement

The collective name for a series of interconnected observation points set up on the ground surface according to defined requirements, which are able to reflect the characteristics of the movement and deformation.

3.1.2 observation frequency

The number of observations and the time interval set as required when the observation station is surveyed.

3.1.3 connect survey

The survey work carried out between the control points and the mining area control network in order to determine the plan position and the elevation of the control points.

3.1.4 comprehensive observation

The survey work carried out after the connect survey, before the surface movement begins

and after the surface has stabilised, in order to determine the plan position and the elevation of the surface movement observation station.

3.1.5 daily observation

The survey work of elevation or plan position carried out between the first and the last comprehensive observation.

3.1.6 three dimensional laser scanning technology

The non-contact survey technique that obtains the three dimensional coordinates of the surface of the object measured, the intensity of the reflected light and other information by emitting a laser. Note: it mainly comprises terrestrial three dimensional laser scanning, vehicle-mounted three dimensional laser scanning and airborne laser radar scanning. [GB 50026-2020, definition 2.1.12, modified]

3.1.7 interferometric synthetic aperture radar

The technique of carrying out interferometric computation on the phase information in SAR data acquired over the same area at different times. [T/CAGHP 013-2018, definition 3.1.3]

3.1.8 low-altitude digital aerial photography

Aerial photography carried out with a digital camera mounted on an unmanned aerial vehicle at a relative flight height of 2 000 m or below. [CH/T 3005-2021, definition 3.1]

3.1.9 data processing

The organisation, computation and analysis of the various kinds of raw data.

3.2 Abbreviations

The following abbreviations apply to this document.

CORS: Continuous Operational Reference System

CORS-RTK: Continuous Operational Reference System - Real-time Kinematic, the network system formed within a given area by several continuously operating fixed global satellite positioning subsystems built at defined intervals

CR-InSAR: Corner Reflector InSAR

CPT-InSAR: Coherent Pixel Technique InSAR

D-InSAR: Differential InSAR

DS-InSAR: Distributed Scatterer InSAR

InSAR: Interferometric Synthetic Aperture Radar

GNSS: Global Navigation Satellite System

LiDAR: Light Detection and Ranging