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Technical Code for Designing of Telecommunication Lines Against Danger Effects from DC Power Transmission Lines

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Contents

Foreword

This code is prepared in response to the arrangement made by the *Notice on Issuing the Plan for Supplementing Electric Power Industry Standard 2003 Issued by the General Office of National Development and Reform Commission* (FGBGY〔2003〕873).

The large-scale construction of HVDC transmission lines and the increasingly growing transmission voltages are bound to cause electromagnetic interference to the adjacent telecommunication lines. Unfortunately, no material and literature in China and foreign countries has systematically presented the harmful effects caused by DC transmission lines to the adjacent telecommunication lines and the relevant protection measures, the relevant influencing mechanism and the calculation methods in this respect. Additionally, no unified calculation and design standard is available in China. In light of this, it makes great sense to establish this code to support the engineering design of DC transmission lines, address the actual problems of a project, improve the design quality of communication protections, make the project construction cycle less time consuming and reduce the investment costs of the project.

This code places emphasis on describing the unique characteristics of the design of DC transmission lines that may cause adverse effects to the adjacent telecommunication lines. Since the design of DC transmission lines has much in common with that of AC transmission lines, DL/T 5033 — 2006 *The Design Rules of Telecommunication Lines Against Danger and Interference Effects From Power Transmission Lines* may be taken as a reference.

Appendices A and B to this code are normative.

This code is proposed by China Electricity Council.

This code is solely managed and interpreted by Technical Committee on Electric Power Planning and Engineering of Standardization Administration of Power Industry.

This code is mainly drafted by Central Southern China Electric Power Design Institute.

The organizations participating in drafting this code include China Power Engineering Consulting Group Corporation, Northeast China Electric Power Design Institute, East China Electric Power Design Institute, Southwest Electric Power Design Institute, and Guangdong Electric Power Design and Research Institute.

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This code is translated by SUNTHER Translation & Solutions under the authority of China Electric Power Planning & Engineering Association.

1 Scope

This code specifies the permissible value of danger effects on telecommunication lines from DC transmission lines, presents the calculation methods of danger effects, and provides necessary parameters and protective measures.

This code applies to the design of the protections that protect telecommunication lines from danger effects caused by the adjacent DC transmission lines.

In addition to this code, the design of the protections that protect telecommunication lines from danger effects caused by the adjacent DC transmission lines shall comply with the provisions of the national standards currently in force as well.

2 Terms and Definitions

The following terms and definitions apply to this code.

2.0.1

Telecommunication lines

Communication lines in forms of overhead open wire, overhead or buried cable, overhead or buried telecommunication optical fiber cable, and railway signal electrical line, cable television (signal, feed and subscriber) line, and remote control and signaling line.

2.0.2

Railway signal electrical lines

Cables and overhead open wires that transmit information for railway signal system, such as relay semi-automatic or automatic obturate way circuit, remote control line, remote signaling line, and railway circuit within the automatic obturate section.

2.0.3

Danger effects

The induced voltage and current on telecommunication lines caused by DC transmission lines can possibly endanger the safety of telecommunication operation and maintenance personnel, damage telecommunication lines or equipment, cause fire to buildings and structures, or cause wrong operation of railway signaling equipment which will bring hazards to traffic safety.

2.0.4

Adjacency

The relative position of telecommunication lines to DC transmission lines when the electromagnetic effects of DC

transmission lines may cause danger to the telecommunication lines.

Parallel adjacency describes a situation in which the variation of distance between two adjacent lines does not exceed 5% of the arithmetic mean of the distance. Oblique adjacency describes a situation in which the variation of distance between two adjacent lines exceeds 5% and increases or decreases linearly (both DC transmission lines and telecommunication lines having no turning points).

2.0.5

Adjacent distance

The distance obtained by perpendicularly drawing a line from any point on the center line of the telecommunication line to that of the DC transmission line.

2.0.6

Length of adjacent sect

The projected length of the adjacent section of the telecommunication lines on the DC transmission lines.

2.0.7

Cross-over

The situation in which DC transmission lines pass through telecommunication lines from overhead.

2.0.8

Inductive coupling effect

Effects of current in DC transmission lines or from the ground on telecommunication lines through inductive coupling.

2.0.9

Capacitive coupling effect

Effects of voltage of DC transmission lines on telecommunication lines through capacitive coupling.

2.0.10

Resistive coupling effect

Effects on the grounding systems and the burial cables of telecommunication offices (stations) caused by ground resistive coupling when the short-circuit current flowing through the grounding system of DC power transmission line towers results in a potential difference between the direct grounding area and the remote ground area.

2.0.11

Magnetic induction endlong electromotance

Potential difference between any two points on a telecommunication line caused by the current in DC transmission line and the ground.

2.0.12

Magnetic induction ground voltage

The ground potential induced at any point on a telecommunication line by the current in the DC transmission line and the ground.

2.0.13

Railway circuit

A circuit in which the tracks of railway are used as conductors to check if there are trains on the railway, transmit the information about the presence of trains and form a communication circuit between the ground and the train.

2.0.14

Automatic obturate way circuit

A circuit used to determine the traveling directions of trains when they are traveling bi-directionally on the same railway within the automatic obturate section (normally in the same route of the

communication lines of railways).

2.0.15

Broadcasting signal lines

Signal transmission lines of the wired broadcasting signal transmission system.

2.0.16

Broadcasting feedback lines

Feedback transmission lines of the wired broadcasting power transmission system.

2.0.17

Broadcasting user's lines

The transmission lines correspond the output end of transformers to the input end of user's equipment used in the wired broadcasting power transmission system.

3 Fault Conditions of DC Transmission Lines and Operating Conditions of Telecommunication Line Circuits

3.0.1 The fault conditions of a DC transmission line that may have danger effects on the adjacent telecommunication lines shall include the following situations:

1 Grounding short-circuit of the pole conductors of mono-polar operated DC transmission lines;

2 Grounding short-circuit of conductors of one pole of bipolar operated DC transmission lines.

3.0.2 When calculating the danger effects on adjacent telecommunication lines caused by DC transmission lines, the following modes should be selected according to the operating conditions of the telecommunication lines.

1 The telecommunication lines have one end grounded through low impedance and the other end grounded through high impedance (open circuit).

2 The telecommunication lines have both ends grounded through low impedance.

3 The telecommunication lines have both ends grounded through high impedance (open circuit).

4 Permissible Value of Danger Effects

4.0.1 In the event of grounding short-circuit fault of the pole conductors of DC transmission lines, the endlong electromotance or the ground voltage induced on the telecommunication lines of the overhead open wires shall not exceed 3000 V (peak value).

4.0.2 In the event of grounding short-circuit fault of DC transmission lines, the permissible value of endlong electromotance or the ground voltage induced on the core wires of the telecommunication cable lines shall comply with the following requirements.

1 Where isolation transformers or lightning protectors are provided at both ends of the core wires of the telecommunication cable lines:

1) For telecommunication cable lines free of long-distance power supply

$$U_s \leqslant 0.85U_{Dt} \quad (4.0.2\text{-}1)$$

$$U_s \leqslant 1.2U_{At} \quad (4.0.2\text{-}2)$$

2) For telecommunication cable lines with long-distance power supply in “conductor-to-earth” mode

$$U_s \leqslant 0.85U_{Dt} - U_{rs} \quad (4.0.2\text{-}3)$$

$$U_s \leqslant 1.2U_{At} - U_{rs} \quad (4.0.2\text{-}4)$$

3) For telecommunication cable lines with long-distance power supply in “conductor-to-conductor” mode and grounded at the center point

$$U_s \leqslant 0.85U_{Dt} - \frac{U_{rs}}{2} \quad (4.0.2\text{-}5)$$

$$U_s \leqslant 1.2U_{At} - \frac{U_{rs}}{2} \quad (4.0.2\text{-}6)$$

Where:

U_{Dt}—DC test voltage of cable core and grounding sheath, V;

U_{At}—AC test voltage (effective value) of cable core and grounding sheath, V;

U_{rs}—long-distance power supply voltage of the sections for which the effects are calculated;

U_s—induced voltage (peak value) of the cable core in the event of faults of DC transmission lines, V.

2 When the conditions in clause 1 of 4.0.2 are not satisfied, the values specified in 4.0.1 shall be used; in this case, the insulation electric strength of the telecommunication lines and equipment at both ends of them as well as the over-current capability of the protection unit shall be considered.

4.0.3 In the event of grounding short-circuit fault of the pole conductor of DC transmission line, the magnetic induction voltages (including magnetic inductive endlong electromotance and magnetic inductive ground voltage) generated on the telecommunication optical fiber cables shall meet the following provisions:

1 For telecommunication optical fiber cable lines which have metal wire pairs and are free of long-distance power supply:

$$U_s \leqslant 0.85U_{Dt} \quad (4.0.3\text{-}1)$$

2 For telecommunication optical fiber cable lines which have metal wire pairs and long-distance power supply:

1) Telecommunication optical fiber cable lines with long-distance power supply in “conductor-to-earth” mode:

$$U_s \leqslant 0.85U_{Dt} - U_{rs} \quad (4.0.3\text{-}2)$$

2) Telecommunication optical fiber cable lines with long-distance power supply in "conductor-to-conductor" mode and grounded at the center point:

$$U_s \leqslant 0.85U_{Dt} - \frac{U_{rs}}{2} \quad (4.0.3\text{-}3)$$

3 Telecommunication optical fiber cable lines with metal members but free of metal wire pairs:

$$U_s \leqslant 0.85U_{Dt} \quad (4.0.3\text{-}4)$$

Where:

U_{Dt} —DC test voltage of outer insulating sheath of optical fiber cables, V;

U_{rs} —long-distance power supply voltage of the sections for which the effects are calculated, V;

U_s —induced voltage (peak value) of the metal members of the optical fiber cables in the event of faults of DC transmission lines, V.

4 Danger effects may not be considered for optical fiber cables free of metal members and wire pairs.

4.0.4 When grounding short-circuit fault occurs at one pole conductor of the DC transmission line, the permissible value of potential difference between the adjacent buried telecommunication cable cores, the metal wire pairs of the telecommunication optical fiber cable, the metal members and the ground, and the permissible value of potential rise on grounding devices disposed at telecommunication office (station) shall comply with the provisions of 4.0.2 and 4.0.3.

4.0.5 Where inductive coupling effect and resistive coupling effect are simultaneously caused by DC transmission lines to underground telecommunication cables or telecommunication optical fiber cables,

the resultant value shall comply with the provisions of 4.0.2 and 4.0.3.

4.0.6 If the composite effects of magnetic induction endlong electromotance and the ground potential rise exceeds the permissible value, the ground voltage of the telecommunication line conductors must be further calculated according to the operating conditions of the telecommunication circuit described in 3.0.2.

5 Calculation of Danger Effects

5.1 Provisions of Calculation

5.1.1 When grounding short-circuit fault occurs at DC transmission lines, the magnetic danger effects on the telecommunication lines caused by the fault current originating from the rectifier station side shall be considered; when checking the ground voltage of the telecommunication lines, the magnetic danger effects on the telecommunication lines caused by the fault current originating from the inverter station side may be considered.

5.1.2 The effects caused by DC transmission lines to the underground telecommunication cable lines and the telecommunication optical fiber cable lines shall include resistive coupling effect which shall be calculated based on the short-circuit current flowing through the tower grounding device when one pole conductor of the DC transmission lines experiences grounding short-circuit faults.

5.1.3 Where DC transmission lines cause both inductive and resistive coupling effects to buried telecommunication cable lines and optical fiber cable lines, the resultant effect shall be calculated as the square root of the sum of squares of both effect values.

5.1.4 For design of telecommunication lines with dischargers for protection at locations such as repeaters, junction cabinets and junction boxes, the ground voltage of telecommunication lines shall be considered when the dischargers operate.

5.1.5 For DC transmission lines with ground wires, the magnetic