ICS 27.100
K 54
Record No. J926—2009

DL

Electric Power Industry Standard of the People's Republic of China

P **DL / T** 5428 — 2009

Technical Code for Design of I&C Protection System in Fossil Fuel Power Plant

Issue Date: July 22, 2009 Implementation Date: December 1, 2009

Issued by the National Energy Administration of the People's Republic of China

Electric Power Industry Standard of the People's Republic of China

P DL / T 5428 — 2009

Technical Code for Design of I&C Protection System in Fossil Fuel Power Plant

CHINA ELECTRIC POWER PRESS

BEIJING, 2011

图书在版编目（CIP）数据

DL/T 5428—2009 火力发电厂热工保护系统设计技术规定=Technical Code for Design of I&C Protection System in Fossil Fuel Power Plant: 英文/国家能源局发布. —北京：中国电力出版社，2012.2

ISBN 978-7-5123-2710-8

Ⅰ. ①D… Ⅱ. ①国… Ⅲ. ①火电厂–热工操作–保护装置–设计规范–英文 Ⅳ. ①TM621.4–65

中国版本图书馆 CIP 数据核字（2012）第 024868 号

中国电力出版社出版、发行

（北京市东城区北京站西街 19 号 100005 http://www.cepp.sgcc.com.cn）

北京博图彩色印刷有限公司印刷

各地新华书店经售

*

2012 年 4 月第一版 2012 年 4 月北京第一次印刷

850 毫米×1168 毫米 32 开本 2.25 印张 52 千字

Contents

Foreword ····· III
1 Scope ····· 1
2 Normative References ····· 2
3 Terms and Definitions, Abbreviations ····· 5
3.1 Terms and Definitions ····· 5
3.2 Abbreviations ····· 9
4 General ····· 10
5 Design Principles of Protection System ····· 11
5.1 Design Principles of Power Supply ····· 11
5.2 Logic Design Principles ····· 12
5.3 Configuration Principles of Protection System ····· 14
5.4 Others ····· 18
6 Boiler Protection ····· 19
6.1 Partial Protection for Boiler ····· 19
6.2 Boiler Furnace Safety Protection ····· 21
6.3 Boiler Trip Protection ····· 26
7 Boiler Burner Control ····· 33
7.1 Ignition and Combustion-Supporting ····· 33
7.2 Pulverized Coal Burner Control ····· 36
7.3 Start and Stop Conditions of Coal Mill ····· 37
7.4 Start and Stop Conditions of Coal Feeder ····· 38
7.5 Start and Stop Conditions of Pulverized Coal Feeder (Exhauster) ····· 39
8 Steam Turbine Generator Unit Protection ····· 41
8.1 Partial Protections for Steam Turbine ····· 41
8.2 Steam Turbine Generator Unit Trip Protection ····· 42

8.3 Protection for Prevention of Water and Cold Steam Damage to Steam Turbine ····· 43
8.4 Protection for Deaerating Feedwater System ····· 47
8.5 Protection for Steam Turbine Bypass ····· 48
8.6 Protection for Air Cooling Unit ····· 49
9 Operation, Display and Signals ····· 50
9.1 Operation ····· 50
9.2 Display and Signals ····· 51
10 Protection Equipment and Sampling System ····· 58
10.1 Instrumentation ····· 58
10.2 Flame Scanner and Ignition Gun ····· 59
10.3 Actuator ····· 60
10.4 Protection Device ····· 61
10.5 Sampling System ····· 62

Foreword

This code is revised according to *Circular of the General Office of National Development and Reform Commission on the Issuance of 2006 Industrial Standard Program* (FGBGY [2006] No. 1093).

This code is put forward by China Electricity Council.

This code is interpreted and under jurisdiction by Electrical Planning and Design Standardization Technical Committee of Power Industry.

This code is drafted by CPECC Southwest Electric Power Design Institute.

This code is mainly drafted by Zhang Jinbin, Xu Huiqiang, Yu Haiping, Song Chun, Zhang Yu and Du Shaomao.

This code comes into effect since the implementation date, in lieu of the complete contents of DLGJ 116—1993 *Technical Regulations on Design of Furnace Safe Supervisory System in Fossil Fuel Power Plant* and "Chapter Ⅵ Protection" of NDGJ 16—1989 *Technical Regulations on I&C Automation Design in Fossil Fuel Power Plant.*

Suggestions and comments during application of this code shall be fed back to the Standardization Center of China Electric Council (No.1, 2nd Lane, Baiguang Road, Beijing, 100761).

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

1 Scope

This code specifies the design principles and design methods that shall be followed in power supply, logic and protection system configuration as well as equipment part of protection system in fossil fuel power plant.

This code is applicable to the design of new construction, expansion and betterment projects for condensing fossil fuel power plants with steam turbine generator unit rated 125MW– 1000MW, as well as the design of thermal power plants with capacity of 50MW and above.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this code. For dated references, subsequent amendments (excluding the contents of errata) to, or revision of, any of these publications do not apply. However, parties to agreements based on this code are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

GB/T 5578—2007 *Fixed Power Plant Turbine Specifications*

GB/T 13399—1992 *Specification for S team T urbine Safety Monitoring Devices*

GB/T 13983—1992 *Instruments—Vocabulary—Basic Terms*

GB/T 17626.2—2006 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Electrostatic Discharge Immunity Test*

GB/T 17626.3—2006 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Radiated Radio-Frequency Electromagnetic Field Immunity Test*

GB/T 17626.4—2008 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Electrical Fast Transient/Burst Immunity Test*

GB/T 17626.5—2008 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Surge Immunity Test*

GB/T 17626.6—2008 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Immunity to Conducted Disturbances Induced by Radio-Frequency Fields*

GB/T 17626.8—2006 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Power Frequency Magnetic Field Immunity Test*

GB/T 17626.9—1998 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Pulse Magnetic Field Immunity Test*

GB/T 17626.10—1998 *Electromagnetic Co mpatibility—Testing and Measurement Techniques—Damped Oscillatory Magnetic Field Immunity Test*

GB/T 17626.11—2008 *Electro*magnetic *Co mpatibility—Testing and Measurement Techniques—Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests*

GB/T 17626.12—1998 Electro*magnetic Compatibility—Testing and Measurement Techniques—Oscillatory Waves Immunity Test*

GB/T 20438.1—2006 *Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related Systems—Part 1: General Requirements*

GB/T 20438.2—2006 *Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related Systems—Part 2: Requirements for Electrical/Electronic/Programmable Electronic Safety-related Systems*

GB/T 20438.3—2006 *Functional Safety of Electrical/Electronic/ Programmable Electronic Safety-related Systems—Part 3: Software Requirements*

GB/T 21109.1—2007 *Functional Safety—Safety Instrumented Systems for the Process Industry Sector—Part 1: Framework Definitions System Hardware and Software Requirements*

GB 50217—2007 *Code for Design of Cables of Electric Engineering*

GB 50229—2006 *Code for Design of Fire Protection for Fossil*

Fuel Power Plants and Substations

DL/T 435—2004 *Code for the Prevention of Pulverized Coal Firing Furnace Explosions/Implosions in Power Plant Boilers*

DL/T 589—1996 *Directives of Thermal Instrumentation and Control for Coal Fired Boiler in Power Plant*

DL/T 590—1996 *Directives of Thermal Instrumentation and Control for Condensation Type Turbine in Power Plant*

DL/T 591—1996 *Directives of Thermal Instrumentation and Control for Turbo-Generator in Power Plant*

DL/T 592—1996 *Directives of Thermal Instrumentation and Control for Boiler Feedwater Pump in Power Plant*

DL/T 641—2005 *Electric Valve Actuators for Power Plant*

DL/T 701—1999 *Thermopower Automation–Vocabulary for Fossil Fired Power Plant*

DL/T 711—1999 *Test Guide of Steam Turbine Governing System*

DL/T 834—2003 *Guide for the Prevention of Water and Cool Steam Damage to Steam Turbines in Fossil Power Plant*

DL/T 892—2004 *Specification of Steam Turbine for Power Plant*

DL 5000—2000 *Technical Code for Designing Fossil Fuel Power Plant*

DL/T 5182—2004 *Technical Rule for Designing of Local Equipment Installation, Pipeline and Cables of I&C in Power Plant*

SD 268—1988 *Specification for Power Station Coal Fired Boiler*

NFPA 85—2004 *Boiler and Combustion Systems Hazards Code*

ASME TDP-1 — 1998 *Recommended Practices for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation*

3 Terms and Definitions, Abbreviations

In addition to the terms and definitions specified in GB/T 13983 and DL/T 701, the following terms and definitions, as well as abbreviations are applicable to this code.

3.1 Terms and Definitions

3.1.1

One out of two for binary variable

Logic consisting of two binary variables reflecting the same event. When any variable is “true”, the logic output is “true”.

3.1.2

Two out of three for binary variable

Logic consisting of three binary variables reflecting the same event. When any two variables are “true”, the logic output is “true”.

3.1.3

Dual redundancy for analog variable

One variable is measured simultaneously by two analog variable transmitters or sensors for mutual standby.

3.1.4

Triple redundancy for analog variable

One variable is measured simultaneously by three analog variable transmitters or sensors for mutual standby.

3.1.5

Multiple redundancy for analog variable

One variable is measured simultaneously by more than three analog variable transmitters or sensors, for mutual standby.

3.1.6

Programmable electronic

Based on computer technology, programmable electronic can be composed of hardware, software, and their input and (or) output units.

3.1.7

Logic system

The part used to perform the decision and transition for functional logic in this system. A logic system provides output in particular sequence to respond to external input and internal logic. Logic system includes:

1 Hardwired system: devices and their interconnecting wiring.

2 The system based on microprocessor.

1) Computer hardware, power supply, I/O device and their interconnecting parts.

2) Operating system and logic software.

3.1.8

Programmable electronic logic system

Logic system based on one or more programmable electronic devices, used for control, protection or monitoring, which includes all elements in the system, such as power supply, input device, data highway, other communication channels, and output device, etc.. For example: PLC, DCS, etc..

3.1.9

Safety function

The function realized by safety-related programmable electronic system, other technical safety-related systems or external risk reduction facilities in respect of certain hazardous events, in order to achieve or maintain the safety state of controlled equipment.

3.1.10

Safety-related system

The specified system must be capable of realizing the required safety function to achieve or maintain the safety state of equipment controlled; the system alone or together with other safety-related programmable electronic systems, other technical systems or external risk reduction facilities can achieve the safety integrity required by the necessary safety function.

3.1.11

Safety integrity

The probability that safety-related system successfully achieves the safety function required under conditions specified and within the time specified.

3.1.12

Safety integrity level; SIL

A discrete level (one of the four possible levels), used to specify the safety integrity requirements of safety function assigned to safety-related programmable electronic system. SIL 4 herein is the highest, and SIL 1 is the lowest. See Table 3.1.12.

Table 3.1.12 Safety Integrity Level: Target Failure Variable for Safety Function Assigned to a Programmable Safety-Related System in Demanding or Continuous Operation Mode

Safety Integrity Level	Demanding or Continuous Operation Mode (Dangerous Failure Probability per Hour)
SIL 4	$\geqslant 10^{-9}$ and $< 10^{-8}$
SIL 3	$\geqslant 10^{-8}$ and $< 10^{-7}$
SIL 2	$\geqslant 10^{-7}$ and $< 10^{-6}$
SIL 1	$\geqslant 10^{-6}$ and $< 10^{-5}$
Note: see Para. 7.6.2.9 in GB/T 20438.1—2006 for detailed explanation	

3.1.13

Burner pair

The two diagonal burners on the same layer of tangentially fired furnace consist of one “burner pair”.

3.1.14

Pulverized coal feeder pair

In case that coal pulverizing system with storage bin and tangentially fired furnace are used, the pulverized coal feeders corresponding to the “burner pair” consist of one “pulverized coal feeder pair”.

3.1.15

Mass airflow

The value of airflow stated with mass as equivalent.

3.1.16

Local ignition

Performing ignition for burners one by one locally.

3.1.17

Remote ignition

Performing ignition for burners one by one in control room.

3.1.18

Automatic ignition

Performing ignition for burners automatically as per the stipulated ignition logic.

3.1.19

Environmental condition

The physical, chemical and biological conditions around instrumentation and protection and control equipment, including ambient temperature, relative ambient humidity, ambient pressure, electromagnetic field, gravity, inclination, power supply voltage and

frequency changes, harmonic wave, radiation, impact, vibration, corrosion, erosion, and flammable and combustible conditions.

3.2 Abbreviations

DCS: Distributed Control System

PLC: Programmable Logic Controller

UPS: Uninterrupted Power Supply

SOE: Sequence of Event

SIL: Safety Integrity Level

MFT: Master Fuel Trip

OFT: Oil Fuel Trip

FCB: Fast Cut Back

RB: Run Back

FSSS: Furnace Safety Supervisory System, composed of FSS and BCS

FSS: Furnace Safety System

BCS: Burner Control System

I/O: Input/Output

ETS: Emergency Trip System

DEH: Digital Electro-Hydraulic Control System

MCS: Modulation Control System

SCS: Sequence Control System

PCV: Pressure Control Valve

CPU: Central Processing Unit

SPDT: Single-Pole Double-Throw

DPDT: Double-Pole Double-Throw

4 General

4.0.1 Design of the protection system is an important part of I&C automation design in power plant, which shall be conducted according to the features of the unit, using equipment and components of advanced technology and reliable quality. New products and new technologies can only be adopted after successful tests and verification or other applicable evaluations.

4.0.2 Approved Standard design, typical design and reference design shall be adopted actively for design of the protection system in power plant.

4.0.3 In designing the protection system, regulations of DL 5000 and the current related national standards and industrial standards shall be implemented, and the requirements of this code shall be met.

4.0.4 In design of the protection system, integrated coordination shall be made with related control system, interlocking device, operation and process equipment and system.

5 Design Principles of Protection System

5.1 Design Principles of Power Supply

5.1.1 AC single-phase protection power supply shall be of voltage 220V, with allowable voltage fluctuation range 176V–264V, and allowable frequency fluctuation range 47.5Hz–52.5Hz; DC power supply can be either of voltage 220V with allowable fluctuation range 176V–286V, or of voltage 110V with allowable fluctuation range 88V–143V.

5.1.2 All protection devices shall be equipped with two AC 220V power supplies, one of which shall be AC uninterruped power supply (UPS), while the other of which shall be led from auxiliary emergency power supply or auxiliary low-voltage busbar. Where redundant UPS power supply system is provided, the two incoming lines can be powered by the UPS power supply, but shall be connected to different supply busbars. Two DC 220V (or 110V) power supplies can also be used, with DC current led from DC panel of battery. The two power supplies shall be in mutual standby and be transferred from one to the other automatically, with the transfer time interval not affecting normal functions of protection system.

5.1.3 When DC protection trip circuit is used, bipolar control shall be adopted, that is, the positive and negative sides are activated simultaneously.

5.1.4 The hardwired protection logic circuit and the independent protection drive circuit shall be equipped with power fuses or trippers respectively, and power supply monitoring shall be arranged for