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Technical Rule of Instrumentation and Control Design for Auxiliary System (Shop) of Fossil-fueled Power Plant

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Contents

Foreword

In accordance with the *Notice on Distribution of Development and Revision of Electric Power Industry Standards in 1997* (Zongkejiao [1998] No.28) issued by the former Ministry of Power Industry, this *Technical Rule of Thermal Power Instrumentation and Control Design for Auxiliary System (Shop) of Fossil-fueled Power Plant* was established.

This rule has summarized the experience in instrumentation and control design of auxiliary system (shop) of fossil-fueled power plants since 1990s, and particularly, it has reflected the characteristics of the development of modern network technology, adopted new technologies and new products widely and introduced advanced technologies both at home and abroad. The preparation of the clauses in the standard keeps in line with the national standard. The design principle and standard for instrumentation and control are prepared according to the different process systems of the auxiliary system (shop) of the fossil fuel power plant.

This rule was proposed by China Electricity Council.

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

Drafting organization of the standard: Northwest Electric Power Design Institute.

The main drafter of this standard is Tian Hong.

1 Scope

The instrumentation and control design requirements of the auxiliary system (shop) of fossil-fueled power plant of condensing type, steam supply type, captive power plant as well as gas turbine power plant are stipulated in this standard.

The standard is applicable to the design a newly-built power plant and may be referenced when designing an expanded plant, a technically modified plant, a captive plant as well as a gas turbine plant.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB 50229 *Code for Design of Fire Protection for Fossil-fueled Power Plant and Substations*

GB 50058 *Code for Design of Electrical Installation in Explosive and Fire Hazard Environment*

GB 50116 *Code for Design of Automatic Fire Alarm System*

DL 5000 *Technical Code for Designing Fossil-fueled Power Plants*

3 General

3.0.1 The instrumentation and control (I&C) design for the auxiliary system (shop) constitutes an important part of the instrumentation and control design for power plant and shall observe the principle of "safety and reliability, economy and suitability, compliance with national conditions" so as to tailor the design to features of power generation units. The equipment and components that employ advanced technology and have reliable quality shall be used.

3.0.2 The instrumentation and control design for the auxiliary system (shop) of the fossil-fueled power plant shall actively adopt standard design, reference design, typical design and generic design.

3.0.3 The standard is the supplement and embodiment of the instrumentation and control part as described in DL 5000. The instrumentation and control design of the auxiliary system (shop) shall be carried out in accordance with DL 5000 and the relevant national standards and industry standards and shall meet the requirements of the standard.

4 Technical Specifications of Control and Monitoring

4.1 Degree of Automation

4.1.1 The degree of automation for the auxiliary system (shop) shall be subjected to comprehensive consideration in terms of control philosophy, configuration and function of instrumentation and control system, operational arrangement as well as controllability of the equipment in the auxiliary system (shop).

4.1.2 The process system (equipment) of the auxiliary system shall be suitable to the degree of automation.

4.1.3 The degree of automation of the auxiliary systems (shops) shall be designed such that the control systems and control points are appropriately combined based on the division and physical locations of the auxiliary process systems of similar nature and the neighboring auxiliary shops. The number of monitoring points assigned to the auxiliary systems (shops) should not be larger than three (respectively used for the coal, ash and water system). The other shops may be designed to operate under unattended mode. The control points shall each be controlled and monitored by an upper computer.

4.1.4 The degree of automation for the auxiliary systems which are centrally controlled and monitored by an upper computer shall achieve the extent that, by using the computer network technology, the operators shall be able to control startup/shutdown of the auxiliary systems (shops), monitor normal operation and adjustment thereof as

well as disposition of abnormal equipment operation and emergency conditions with the assistance of the walk-around inspection personnel via an upper computer from the control room of the auxiliary systems (shops).

4.1.5 The auxiliary systems (shops) which are centrally controlled should have a closed circuit television monitoring system provided in an unattended shop (area), which shall be considered together with the closed circuit television monitoring system of the main power building in order to monitor the local equipment.

4.1.6 The auxiliary systems (shops) that are monitored and controlled through programmable logic control (PLC) and upper computers shall not be provided with conventional display, recording instruments and alarm window.

4.1.7 The auxiliary system (shops) that are monitored and controlled through PLC and upper computers shall not be provided with conventional manual operation.

4.1.8 The auxiliary systems (shops) including but not limited to the following listed below shall adopt PLC control and may also adopt small-sized DCS or dedicated controller if justified through techno-economic analysis:

1 Boiler make-up water system.
2 Condensate desalting system.
3 Air conditioning system.
4 Ash and slag (pyrites) handling system.
5 Wastewater treatment system.
6 Coal handling system.
7 Electrostatic precipitator system.
8 Reverse osmosis system.
9 Chemical dosing system.

10 Steam water sampling system.
11 Purification station.
12 Fuel oil pump house.
13 Hydrogen generating station.
14 Weak acid treatment.
15 Raw water pretreatment.
16 Sewage treatment.

4.1.9 The monitoring and control of the desulphurization system should be carried out by using an independent distributed control system (FGD-DCS) or should be incorporated into the distributed control system (DCS) of the units. The small-sized DCS shall include data acquisition system, modulating control system as well as sequential control system.

4.1.10 The control and monitoring for directly air-cooling system shall be incorporated into the DCS system of the main power building.

4.1.11 The monitoring and control of air compressor system, circulating water pump house, condensate polishing system, steam water sampling system and chemical dosing system may be incorporated into the DCS of the main power building.

4.2 Control Philosophy

4.2.1 By adherence to the principle of appropriately combining the similar auxiliary systems (shops), a local central control room used for the coal, ash and water system may be arranged based on the functional division of the process systems and the physical locations thereof, and, if the conditions permit, the number of the control points may be further reduced.

4.2.2 The central control room of ash system should include the

control for the following auxiliary systems (shops) including but not limited to:

1 Ash handling system.

2 Slag and pyrites handling system.

3 Electrostatic precipitator system.

4 Limestone conveying system (in case of circulating fluidized bed units).

4.2.3 The central control room of water system should include the control for the following auxiliary systems (shops) including but not limited to:

1 Boiler make-up water system.

2 Condensate polishing system (it may be incorporated into the DCS system based on the power plant management).

3 Chemical sampling.

4 Chemical dosing system.

5 Reverse osmosis system.

6 Sewage treatment system.

7 Purification station.

8 Hydrogen generating station.

9 Weak acid treatment.

4.2.4 The central control room of ash system may be located in the ash handling control building.

4.2.5 The central control room of water system may be located in the chemical make-up water system.

4.2.6 The control of fuel oil pump house should be incorporated into the DCS of the main power building or may be incorporated to other control points.

4.2.7 The start-up boiler house may use local centralized control mode.

4.2.8 The heating network station may have its control incorporated into the DCS of the main power building.

4.2.9 The monitoring and control of the fire alarm system should be arranged in the unit control room of the main power building.

4.2.10 The monitoring and control of air conditioning system may be arranged in the unit control room of the main power building.

4.3 Structure of Control System

4.3.1 General Rules of the Control Network System

1 The central control network systems respectively designed for the coal, ash and water system may use the topology structure of bus network, star network or ring network.

2 The communication rate, communication distance of the network system shall be sufficient to meet the requirement of real-time control and monitoring of the auxiliary systems (shops) and shall take into account the fact that the auxiliary systems (shops) are scattered and are relatively far apart between each other.

3 The control network systems used for the coal, ash and water system shall be able to communicate with the DCS of the main power building, and the supervisory information system (SIS) shall be able to be interconnected such that the monitoring and control as well as information management in the whole plant can be performed through a network. The interconnection between different types of networks should adopt standard protocols and interfaces of open type.

4 Two operator stations which are able to back up each other may be provided for the ash control system to act as the upper computers.

5 Two operator stations which are able to back up each other may be provided for the water control system to act as the upper computers.

6 The network transmission media should adopt the optical fiber communication cable, and Coaxial cable, shielded twisted pair as well as a combination thereof may also be adopted provided that the technical requirements can be satisfied.

7 The trunk network communication shall be redundantly provided such that failure of a communication line will not adversely affect the communication of the control system. The auxiliary systems (shops) that are far apart or that are critical should employ redundant communication mode when transmitting monitoring and control information through remote I/O bus.

8 The critical network equipment should be arranged in hot standby mode.

4.3.2 General Rules for Programmable Logic Controllers (PLCs)

1 The PLCs for the following critical auxiliary systems (shops) should be configured in dual hot standby mode:

1) Ash and slag (pyrites) handling system.
2) Condensate polishing system.
3) Fuel oil pump house.
4) Limestone conveying system (in case of circulating fluidized bed units).

2 The auxiliary systems (shops) whose controlled objects are scattered and far apart may adopt remote I/O.

3 The PLC devices for different auxiliary systems (shops) shall have uniform series and specifications.

4 The central processing unit (CPU) should be provided with memory with adequate capacity, considering 40% of the total capacity as spare capacity.

5 Input/Output (I/O) Components.

10% of the I/O total quantity should be reserved for spare; in addition, 15% of the total slots are reserved for expansion.

Common-mode rejection ratio≥90 dB

Differential mode rejection ratio≥60 dB

6 The protection class of the remote I/O cabinets shall be IP56 and shall satisfy the actual environmental requirements at site.

4.3.3 Power Supply and Grounding

1 The power supply of the control network systems for coal, ash and water system shall be highly reliable. AC uninterrupted power supply (UPS) shall be provided for the computer system located in the central control room.

2 The AC UPS shall adopt single-phase power supply: AC 220 V, 50 Hz.

3 PLC devices of the control network systems used for coal, ash and water system should be reliably grounded.

4.4 Equipment Selection

4.4.1 On the premise of satisfying the requirements of safe and economical operation, configuration of the measuring instruments shall be optimized to avoid duplicate configuration.

4.4.2 The instrumentation to be installed at sites in potentially inflammable and explosive environment should meet the requirements of GB 50058 and shall be of explosion proof type.

4.4.3 The instruments used to measure corrosive or viscous medium shall be corrosion resistant or of isolation type or suitable isolation measures shall be taken therefore.

4.4.4 The instruments shall be selected to accommodate program-controlled interlocking requirements and must operate safely and reliably.

4.4.5 The digital instruments shall have reliable quality. Double-pole double-throw switches with the capacity of 220 V AC, 3 A and, 110 V DC, 1 A should be selected therefore.

4.5 Requirements of Installation

4.5.1 Except for primary instruments, any instrumentation shall not be arranged in the acid, alkali metering room and acid & alkali storage room.

4.5.2 For purification station, hydrogen generating station, sewage treatment system, reverse osmosis system, chemical sampling and dosing system, weak acid treatment system, condensate polishing system as well as comprehensive pump house, PLCs or remote I/Os shall be arranged in their respective shops.

4.5.3 If the control air supply of the ash and slag (pyrites) handling system is proximate to the main power building, then the instrument air supply in the main power building shall be adopted.

4.5.4 The ash hopper, blower fan house, ash silo, dewatering bin, pump house of electrostatic precipitators shall be provided with remote I/O.

4.5.5 The auxiliary systems (shops) that are corrosive, such as boiler make-up water system and condensate polishing system, shall be arranged overhead by using corrosion resistant cable trays and cable trenches shall not be arranged in the shops.

4.6 Control System Design

4.6.1 The ash & slag handling systems of two boilers as well as the common system may be designed with a single control system; alternatively, separate control systems may be designed for each of the boilers and the common system.

4.6.2 The design of the fire alarm and detection system for fossil-fueled power plants shall meet the requirement of GB 50229 and GB 50116.

4.6.3 The interlocking between air conditioning system and fire alarm and detection system shall be taken into consideration during design.

4.6.4 The fire alarm and detection system of rotary air preheaters shall be designed with an interface to connect with the plant-wide fire alarm and detection system.

4.6.5 The detection probes and control components for fire protection interlocking shall adopt double-probe and double-component design.

5 Monitored and Controlled Items

5.1 Main Detected Items

Refer to Table 5.1 for the main detected items.

Table 5.1 Main Detected items

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Ash and slag handling system	1	Level of precipitator ash hopper			√		
	2	Level of air preheater ash hopper			√		
	3	Level of economizer ash hopper			√		
	4	Inlet pressure of conveying blower		√	√		
	5	Outlet pressure of conveying blower		√	√		
	6	Inlet pressure of aerification fan			√		
	7	Outlet pressure of aerification fan			√		
	8	Ash handling pipe pressure	√	√			

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Ash and slag handling system	9	Level of ash silo		√	√		High value alarm
	10	Differential pressure across the filter of ash silo			√		High, low value alarm
	11	Water level of slag hopper		√	√		High, low value alarm
	12	Water level of overflow tank of the slag hopper		√	√		
	13	Water level of transfer storage bin		√	√		
	14	Sealing water pressure of slag handling pump	√	√			
	15	Slag handling header pressure	√	√			
	16	Level of dewatering bin		√			
	17	Level of pyrites hopper		√			
	18	Water level of reservoir		√	√		High, low value alarm
	19	Water level of ash-slurry pond		√	√		High, low value alarm

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Circulating water pump house	1	Outlet pressure of circulating water pump	√	√			
	2	Header pressure of circulating water pump		√	√		
	3	Differential pressure across the rotating type screen			√		
	4	Sump water level			√		
	5	Bearing temperature of circulating water pump	√	√			
	6	Stator winding temperature of motor of circulating water pump		√			
	7	Circulating water pump motor current					
Chemical sampling system	1	Economizer inlet pH value		√			
	2	Boiler water conductivity		√			
	3	Saturated steam conductivity		√			
	4	Superheated steam conductivity		√			
	5	Economizer inlet conductivity		√			

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Chemical sampling system	6	Condensate water conductivity		√			
	7	Condensate water pH value		√			
	8	Oxygen content of deoxidized feed water		√			
	9	Reheated steam conductivity		√			
Boiler make-up water treatment system	1	Raw water flow of cation exchanger inlet header		√			
	2	Raw water temperature of cation exchanger inlet header		√			
	3	Raw water pressure at cation exchanger inlet header		√			
	4	Raw water flow at cation exchanger inlet		√			
	5	Water flow at weak caustic anion exchanger inlet		√			
	6	Water flow at strong caustic anion exchanger inlet		√			
	7	Water flow at mixed bed inlet		√			

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Boiler make-up water treatment system	8	Conductivity at strong caustic anion exchanger outlet		√		√	High value alarm
	9	Conductivity at mixed bed outlet		√		√	High value alarm
	10	Service demineralized water header flow at anion exchanger inlet		√			
	11	Conductivity at demineralized water pump outlet header		√			
	12	Demineralization pump outlet header pH value		√			
	13	Demineralized water pump outlet header flow		√			
	14	Demineralized water pump outlet header pressure	√	√			
	15	Intermediate water tank level of decarburized device		√	√	√	High, low value alarm
	16	Demineralized water tank level		√	√	√	High, low value alarm

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Boiler make-up water treatment system	17	Demineralized water pump outlet pressure display	√	√			
	18	Acid ejector outlet acid concentration		√			
	19	Alkali heater outlet alkali temperature		√			
	20	Alkali heater outlet alkali concentration		√			
	21	Alkali heater inlet steam temperature		√			
	22	Acid pump outlet acid pressure	√				
	23	Acid liquor storage tank level			√		
	24	Acid metering device liquid level			√		
	25	Demineralized water flow at inlet of acid ejector	√				

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Boiler make-up water treatment system	26	Demineralization water pressure at inlet of acid ejector	√				
	27	Alkali pump outlet pressure	√				
	28	Alkali liquor storage tank level					
	29	Alkali metering device liquid level	√				
	30	Demineralization water flow at inlet of alkali ejector		√			
	31	Demineralization water pressure at inlet of alkali ejector	√				
	32	Alkali heater inlet steam pressure		√			
	33	Demineralized water pump current		√			
	34	Clean water pump current		√			
	35	Service demineralized water pump current		√			

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Boiler make-up water treatment system	36	Intermediate water pump current		√			
Reverse osmosis demineralization system	1	Pressure at inlet of heater header	√	√			Low value alarm
	2	Pressure at outlet of heater header	√				
	3	Heater inlet temperature	√				
	4	Heater outlet temperature	√	√		√	High, low value alarm
	5	Heating steam pressure	√				
	6	Heater steam temperature	√				
	7	Precise filter inlet (outlet) header turbidity		√		√	High value alarm
	8	Precise filter inlet header flow		√			
	9	Precise filter inlet flow		√		√	Low value alarm
	10	Precise filter inlet header pressure		√		√	Low value alarm

Table 5.1 (continued)

Designation of Auxiliary Systems (shops)	No.	Designation of Measuring Points	Local	PLC Upper Computer or DCS			Remarks
				Analog	Digital	Alarm	
Reverse osmosis demineralization system	11	Precise filter inlet pressure	√				
	12	Precise filter outlet pressure	√				
	13	Differential pressure across precise filter			√	√	High value alarm
	14	Activated carbon filter inlet flow		√			
	15	Activated carbon filter inlet header pressure		√			
	16	Activated carbon filter inlet pressure	√				
	17	Activated carbon filter outlet pressure	√				
	18	Differential pressure across activated carbon filter			√	√	High value alarm
	19	Safety filter inlet header pressure		√			
	20	Safety filter inlet header temperature		√			
	21	Safety filter inlet header conductivity		√			