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Code for Distributed Control System Engineering Design

分散型控制系统工程设计规范

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2 Normative References

The following referenced documents are indispensable for the application of this code. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

"Design Code for Control Room" (HG/T 20508)

"Design Code for Instrument Power Supply System" (HG/T 20509)

"Design Code for Instrument Grounding" (HG/T 20513)

"Procedure for Engineering Design of Instrumentation" (HG/T 20636.7)

"Common Terms and Definition for Measurement and Control System Design" (HG/T 20699) design

"Terms for Distributed Control System" (JB/T 9268-1999)

"Design Code for Instrument System Lightning Surge Protection Engineering in Petrochemical Engineering" (SH/T 3164-2012)

3 Terms, Definitions and Abbreviations

3.1 Terms and Definitions

For the purpose of this code, the following terms and definitions apply.

3.1.1 Application software

The generic term of computer programs, processes, regulations and relevant documents required to let DCS complete the supervision on a certain production process.

3.1.2 Availability

The ratio of the time for one device or system to correctly perform its designated function to the total time to perform this intended function as planned, which is expressed in percent.

3.1.3 Baseband LAN

A kind of local area network that is able to encode the data and also is able to realize data transmission without wave carrier modulation.

3.1.4 Bridge

A kind of functional unit interconnecting such two local area networks that use the same logical link control protocol but may apply different medium access control protocols.

3.1.5 Broadband LAN

A kind of local area network that is able to encode and reuse the data and also is able to realize data transmission by wave carrier modulation.

3.1.6 Bus network

A kind of local area network that has only one access between any two data stations and in which the data sent by one station is usable for all other stations in the same transmission medium.

3.1.7 Communication system

A kind of system that is composed of various communication links, protocols and functional units and provides the effective communication among the component parts of computer network. This system ensures the information transfer by a decided mode in a group of interconnected stations.

3.1.8 Computer integrated process system-CIPS

The automatic control system integrating such functions as routine control, advanced control, process optimization, production dispatching, enterprise management, operating decision.

3.1.9 Data circuit

A pair of relevant transmitting and receiving access that are provided for the two-way data communication.

3.1.10 Data processing system

A kind of complex that is composed of device, method, program and person and is able to complete a specific group of data processing functions.

3.1.11 Data station

A complete set of functional units that is also known as station and is composed of data terminal equipment, data circuit-terminating equipment and its common interface.

3.1.12 Distributed control system-DCS

A kind of intelligent station network that is characterized by distributed control function, centralized operating display and hierarchical structure. It is applied for the purpose of controlling or controlling and managing an industrial process or factory.

3.1.13 Engineer's operating station

The intelligent station provided for the Engineer at the supervision level of distributed control system to realize the system generation, which generally also has the functions of operator's station.

3.1.14 Ethernet

A kind of networking technology of computer local area network, which specifies link of physical layer, the electric signals and the contents of medium access layer protocol and meets the technical requirements of IEEE 802.3.

The industrial Ethernet is compatible with the commercial Ethernet (IEEE 802.3) technically, but it is better to satisfy the demand of industry site in such aspects as product material selection, product strength, applicability and instantaneity, operability, reliability, interference immunity and intrinsic safety.

3.1.15 Fieldbus

A kind of serial, digital and multipoint communication data bus that is installed between field equipment /instrument in the field of production process and the automatic control device/system in control room.

3.1.16 Fieldbus control system-FCS

Fieldbus technology is the digital network segment technology that is directed to factory low-level automation and information integration. And the automation system based on this technology is referred to as fieldbus control system (FCS).

3.1.17 Function module

Some program modules that are developed in the required format and have such functions as calculation, processing, regulation control, amplitude limiting and alarming.

3.1.18 Gateway

One real body that operates above the link layer. This real body is able to translate the interface and protocol of one network into those of another different network when required.

3.1.19 Life cycle

The total time starting from the process concept design to the out of service of DCS functions.

3.1.20 Local area network-LAN

A kind of data network that is allocated at the user place for the purpose of data communication between the data stations in limited region.

3.1.21 Management level

It is the uppermost level in the hierarchical structure of distributed control system and consists of the supervisory computer and the like. This level mainly have the generalized information management and processing functions, including production dispatching, system coordination, quality control, preparation of management statement documents, acquisition of operation data, performing comprehensive analysis and providing decision support, etc.

3.1.22 Network protocol

A set of rules that designates the interface service of communication system and directs the

4 General Requirements for DCS

4.1 Basic Technical Requirements

4.1.1 Dispersibility.

DCS shall adopt distributed configuration over hardware units to realize the distribution of system functions and operation risks as well as the requirements of formidable function and flexible configuration.

4.1.2 Redundancy.

DCS shall adopt the redundancy configuration of critical units and components to realize the requirements of improving the operation reliability of system.

4.1.3 Openness.

DCS shall have open network structure to support the open standards of OPC. It's an open system complying with OSI (open system interconnection) and IEEE communication standard, which is able to realize the requirements of interconnecting with other DCSs and control/supervisory computers.

4.1.4 Advancement.

DCS shall have advanced hardware and software environment and be able to satisfy the requirements of runners on advanced control and real-time process optimization software.

4.1.5 Expansibility.

It's required to construct the business information system or integrated management automatic system on the basis of DCS by utilizing the openness, extensibility and integrability of DCS.

4.1.6 Reliability.

It's required to ensure the solidity and durability of DCS hardware and the maturity and safety of DCS software, and also to ensure the advancement and reliability of the mean time between failures (MTBF), mean time to repair (MTTR) and availability of the system. The hardware supplier shall obtain the quality management certification of ISO 9000 series standards.

4.2 Application Requirements

4.2.1 Independent application of DCS.

The supervision function of DCS upon the production process shall meet the following requirements:

1 Conduct centralized display, automatic control, remote operation and information management to the operating parameters of the production process.

2 Conduct stepwise or conditional or stepwise + conditional control to the sequential control production process.

4.2.2 Combination between DCS and SIS.

Combination scheme of DCS and SIS should adopt the following responsibility distribution

and mutual connection/interlinking mode:

1 DCS is responsible for the supervision on process parameters and the interlocking function of non-safe process, while SIS is responsible for the safety interlocking function of production.

2 DCS adopts hard wiring mode to transmit safety data to SIS.

3 DCS adopts the agreed communication protocol to realize the communication with SIS.

4.2.3 Combination between DCS and upper computer.

The combination of DCS and upper computer shall meet the following requirements:

1 DCS is articulated to advanced control computer to conduct advanced control over the production process.

2 DCS is articulated to the factory information management computer to conduct the enterprise informatization management.

4.2.4 Combination between DCS and other control devices.

DCS shall be able to adopt the communication mode to combine with the following supervision devices/ systems:

1 DCS is used in combination with the auxiliary production plants, complete set of units, and the DCS, PLC, FCS and CCS of other production plants, etc.

2 DCS is used in combination with the asset management system (AMS).

3 DCS is used in combination with the combustible/toxic gas detection system (GDS).

4 DCS is used in combination with the electrical detection system.

4.2.5 Integrated application of DCS, SIS and GDS.

The field instruments of DCS, SIS and GDS systems and the I/O card shall be set independently as required; the controller of DCS, the logic arithmetic unit of SIS and the alarming facility of GDS, with the premise of satisfying their respective configuration specification, shall be integrated and seamlessly linked together into such a process control system (PCS) with more integral functions so as to conduct the integrated control of production and safety.

4.2.6 Application of computer integrated management system.

Computer integrated management system (CIMS) is constructed by integrating the DCS process control technology and the computer information management technology and is used for conducting the enterprise strategies for improving production, optimizing management and improving economic performance, etc.

Functions of DCS in the computer integrated management system shall meet the following requirements:

1 DCS performs the process supervision function of computer integrated management system.

2 DCS transmits the information required by enterprise for the integrated management and control automatic system.

4.3 Hardware Configuration Requirements

4.3.1 Hierarchy configuration of system.

The hierarchical structure of DCS may be composed of three levels, including process control level, supervision level and management level, and the major hardware of every level

5 Design Principles and Responsibility Distribution of DCS Engineering Design

5.1 Design Principles

5.1.1 DCS engineering design shall take comprehensive consideration of practicability, reliability, availability, maintainability, traceability, economical efficiency and expansibility, and shall reasonably adopt the redundant and tolerant technique.

5.1.2 DCS engineering design shall meet such requirements as production operation, DCS purchasing, equipment installation and system commissioning.

5.1.3 DCS control scheme, system configuration and the like shall meet the requirements of the Buyer.

5.1.4 In such engineering project that adopts SIS, the functional division, hardware configuration, control/interlocking signal cross between DCS and SIS shall be specified clearly.

5.1.5 The requirements on the combination of other complete sets of control systems shall be proposed according to the DCS configuration conditions of the main device; DCS also shall satisfy the special combination requirements proposed by the complete set of control systems as required.

5.1.6 After timely receiving the required DCS technical data, the Designer shall guarantee the integrity and accuracy of DCS engineering design documents.

5.1.7 In the DCS engineering design, the design of control room, power supply, grounding and lightning protection that are related to DCS shall comply with those specified in the relevant national standards or relevant professional standards.

5.1.8 Hardware, operating system and programming software of DCS shall adopt the formally issued editions and shall be under effective control according to the specified program.

5.2 Responsibility Distribution

The main works within the life cycle of DCS involved in this code, e.g. DCS engineering design, DCS purchasing, DCS installation and commissioning, as well as the DCS manufacture and after-sale service, are undertook by the designer, buyer and seller respectively, and the responsibility distribution is as follows:

5.2.1 DCS engineering designer is responsible for formulating the DCS supervision scheme, preparing the DCS technical specification and completing the DCS engineering design documents. It may cooperate with the DCS purchasing work according to the provisions of engineering design contract and also participate in the application software configuration, inspection, installation and test run of DCS.

5.2.2 DCS buyer is responsible for the purchasing, inspection, installation, integration test,

6 Control Stations (Process Control Stations)

6.1 Function of Control Stations

6.1.1 The control stations shall be provided with the function of realizing the input and processing of various physical signals and realizing the various real-time conventional continuous control, and also shall be constructed with the corresponding (or similar) function modules, like:

Conventional instrument function module: function modules of the input indication category, governor category, manually operated machine category, signal set category, signal amplitude limiting category, signal selector category, signal distributor category and signal alarm category, etc.

Calculation function module: function modules of the numerical calculation, analog calculation, time function, trend computation, switches and setting, etc.

6.1.2 The control stations shall be provided with such control functions as realizing batch control, sequence/interlocking logic and the like, and also shall be constructed with the corresponding function modules, like the function modules of sequence control function category, switch instrument category and sequential control element category, etc.

6.1.3 The control stations shall have the large-capacity memorizer and very high operational speed as well as the function of realizing various advanced control strategies.

6.2 Structure of Control Stations

6.2.1 Generally, the control station may be composed of process interface unit, control unit (controller) and data acquisition unit (being configured by the DCS manufacturer according to needs).

6.2.2 Generally, the functional cards of every unit of the control station may include the control card, I/O card, auxiliary card, communication interface, card case for installing the card, and bus mother board, etc.

6.2.3 To adapt to the demand of supervision on such areas that are far away from the control room, the control stations shall provide the remote I/O or remote control stations that may be installed dispersedly.

6.3 Technical Requirements of Control Stations

6.3.1 Process I/O interface unit.

1 Process I/O interfaces shall include such types as AI, AO, DI, DO and PI, and shall be provided with the intelligent transmitter interface, serial and parallel communication interfaces, etc.

2 Process I/O card input circuit shall be set with electromagnetic isolation or optoelectronic isolation, and shall meet the provisions on interference resistance as

specified in IEC 61000 or SAMA PMC 33.1.

3 As for the signals coming from or sent to the explosion danger zones, guard grating or intrinsically safe I/O shall be set at the field side of I/O interface when adopting the intrinsically safe explosion protection technology.

4 If the capacity of on-off interface can not meet the load requirements or if the switching value needs to be isolated, the relay shall be set.

5 It shall provide the function of signal check on the defective points beyond the scope of 4~20mA open-circuit and short-circuit signals and the input signals, and this function shall be completed during every scanning process.

6 All the I/O cards shall be provided with I/O state LED indication and other diagnose indications, such as card power supply indication.

7 All the input cards at connection points shall be provided with anti-shake filtering processing function.

8 I/O card of DCS shall be provided with the measures for protecting the over-voltage and over-current of I/O.

9 Where the I/O card is out of order, necessary measures shall be taken to ensure the process system at the safety condition without fluctuation. Where the system power supply is lost, the actuator shall keep the safety positions (full-on, full-off and position retaining, etc.).

10 When configuring the AMS system, the I/O card with HART protocol communication function or other card with similar function.

11 According to the connection demand between signal source and I/O card, converter or isolator may be provided.

12 Within the whole operating ambient temperature range, the precision requirement of I/O card are as follows:

Precision of analog input signal shall be ±0.1%FS;

Precision of analog output signal shall be ±0.1%FS.

6.3.2 Control unit.

1 The control unit shall be based on the multi-functional controller that is set with microprocessor (CPU) and shall be 32-bit machine with internal memory no less than 16MB.

2 It shall provide the software interfaces with diversified PLC and shall be able to communicate with various intelligent instruments according to its communication protocol.

3 The system shall have the self-calibration function of PID parameters.

6.3.3 Data acquisition unit (set as needed).

1 The data acquisition unit shall be able to complete such functions as the data processing, alarming and record of input signals.

2 The scan period of detection point shall be calibrated according to the detected object, which shall not be larger than 1s at most.

6.3.4 Redundancy configuration of control station.

1 The I/O card of control circuit and the I/O card of important detection point should adopt redundancy configuration.

2 CPU of control unit shall be of 1:1 redundancy configuration; and the communication interface and power supply shall be of 1:1 redundancy configuration.

7 Operator's Stations

7.1 Function of Operator's Stations

7.1.1 Operator's station is the interface between system and operating personnel, it is used for the monitoring and operating of the operating personnel to production process and also used for configuration and maintenance. The operator's station shall also be provided with the historical/statistical data collection function and the trend/statement display and print function.

7.1.2 The picture and flow display of operator's station shall be with high resolution and color.

7.1.3 The control and regulating function of operator's station shall start the regulation meter window through flow picture or enter into grouping pictures by controlling the overview picture.

One integral control and regulation picture shall include the bar chart regulation meter, PV, SV, MV, real-time trend picture and circuit parameter list.

The circuit regulation shall be provided with the following specific functions:

Switching over among the manual, automatic and cascade control modes;

Adjustment of SV and MV values;

Calibration of PID parameters, etc.

7.1.4 The trend display function of operator's station shall include real-time trend display and historical trend display. The sampling time of real-time trend curve should be 1s, and the curve time shall be X_{min} at most. The sampling time of historical trend curve may be set as 1min to one month.

7.1.5 The alarming management and display function of operator's station shall be able to display the alarming state timely at any picture.

The alarm printing shall be in time and the first accident alarm shall be sorted out.

7.1.6 The statement management and printing of operator's station may be arranged as required and shall be convenient for configuration. The operator's station shall be provided with the statistical calculation function.

7.1.7 The operator's station shall also be provided with the following functions:

Self-diagnosis function;

Online configuration function;

Password protective function of system operation;

Operating record function;

Online control strategy debug function;

File transfer function.

7.2 Structure of Operator's Stations

7.2.1 Operator's station may be composed of host machine, displayer and operator's

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