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Non-Destructive Testing – Integrated
Non-Destructive Testing – General Principle

无损检测 集成无损检测 总则

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Non-Destructive Testing – Integrated

Non-Destructive Testing – General Principle

1 Scope

This Standard specifies the general principles for integrated non-destructive testing of materials and workpieces.

This Standard is only applicable to materials or workpieces that may be subjected to two or more non-destructive testing methods. Various non-destructive testing methods may be implemented in accordance with their own testing standards, and may also be implemented in accordance with the testing standards of integrated non-destructive testing methods.

This Standard is applicable to the integrated non-destructive testing method whose main feature is the integration of multiple non-destructive testing technologies. It is not applicable to the integrated non-destructive testing method whose main feature is the integration of a single non-destructive testing technology and multiple interdisciplinary industrial technologies.

This Standard provides guidance for the formulation of integrated non-destructive testing standards or testing procedures for specific products, equipment, and materials.

2 Normative References

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this document.

GB/T 9445 Non-Destructive Testing - Qualification and Certification of Personnel

GB/T 12604.1 Non-Destructive Testing - Terminology - Ultrasonic Testing

GB/T 12604.2 Non-Destructive Testing - Terminology - Radiographic Testing

GB/T 12604.3 Non-Destructive Testing - Terminology - Penetrant Testing

GB/T 12604.4 Non-Destructive Testing - Terminology - Acoustic Emission Testing

GB/T 12604.5 Non-Destructive Testing - Terminology - Magnetic Particle Testing

GB/T 12604.6 Non-Destructive Testing - Terminology - Eddy Current Testing

GB/T 12604.7 Non-Destructive Testing - Terminology - Leak Testing

GB/T 12604.8 Non-Destructive Testing - Terminology - Neutron Testing

GB/T 12604.9 Non-Destructive Testing - Terminology - Infrared Testing

GB/T 12604.10 Non-Destructive Testing - Terminology - Magnetic Memory Testing

GB/T 12604.11 Non-Destructive Testing - Terminology - X-Ray Digital Radioscopic Testing

GB/T 16656.1 Industrial Automation Systems and Integration - Product Data Representation and Exchange - Part 1: Overview and Fundamental Principles

GB/T 17645.1 Industrial Automation System and Integration – Part Warehouse - Part 1: Overview and Basic Principles

GB/T 20737 Non-Destructive Testing - General Terms and Definitions

GB/T 22270.1 Industrial Automation Systems and Integration - Service Interface for Testing Applications - Part 1: Overview

GB/T 25485 Industrial Automation Systems and Integration - Functional Architecture of Manufacturing Execution System

GB/T 25486 Networked Manufacturing - Technical Terminology

GB/T 25507 Industry Foundation Classes Platform

3 Terms and Definitions

For the purpose of this document, the terms and definitions given in GB/T 12604.1, GB/T 12604.2, GB/T 12604.3, GB/T 12604.4, GB/T 12604.5, GB/T 12604.6, GB/T 12604.7, GB/T 12604.8, GB/T 12604.9, GB/T 12604.10, GB/T 12604.11, GB/T 16656.1, GB/T 17645.1, GB/T 20737, GB/T 22270.1, GB/T 25485, GB/T 25486 and GB/T 25507 and the following apply.

3.1 Integrated non-destructive testing

A comprehensive technology that integrates two or more independent non-destructive testing methods or technologies, has integrated testing apparatus and/or sensor hardware structure and integrated software structure, and can perform comprehensive processing like data fusion against the acquired test data and realize resource sharing.

It is the main feature of integrated non-destructive testing to realize the integration of multiple non-destructive testing methods through the organic integration of multi-disciplinary technologies such as machinery, electronics, and information. When integrating non-destructive testing, the scanning mechanism and discontinuous position information of different types of testing methods are shared; the sensors of different testing methods have an integrated structure and become an organic whole; the excitation and/or receiving circuits, and the analog-to-digital conversion circuit of different testing methods are shared. By integrating the testing information of different types of non-destructive testing methods, the surface and internal discontinuities and discontinuities of different directions of the tested object can be tested at the same time; it can also test and characterize the surface performance and/or stress state, etc. of the tested object. Therefore, the integrated non-destructive testing apparatus has better economy, the testing process has higher efficiency, and the accuracy and reliability of testing results are higher.

4.2 Technology

Integrated non-destructive testing generally includes the following modes such as non-destructive testing instrument integration, non-destructive testing network integration, and non-destructive testing cloud testing, etc.

The testing performance of the integrated non-destructive testing equipment shall be better than the simple sum of the testing effects of each single testing method, and has the following advantages:

- Economy of the apparatus;
- Comprehensiveness of testing information;
- High testing efficiency;
- Full coverage of the testing range;
- Accuracy and reliability of test results, etc.

Integrated non-destructive testing includes but is not limited to the following technology combinations:

- Eddy current-magnetic memory integrated testing technology: The combination of eddy current sensors and magnetic memory sensors are distributed on the same scanning surface of the sensor to form an integrated working sensor, which can simultaneously pick up discontinuities and stress abnormalities information at the same position of the tested ferromagnetic workpiece;
- Eddy current-electromagnetic ultrasonic integrated testing technology: Excite and receive eddy current and ultrasonic signals in the tested metal workpiece, which can simultaneously test the surface, near surface and internal

The usual testing objects are:

- All kinds of raw materials, and all kinds of workpieces;
- Transportation vehicles, such as ships, rail vehicles, aerospace vehicles;
- large infrastructure;
- Power system facilities;
- Petroleum and petrochemical-related pipelines, storage tanks, and drilling platforms;
- Other major facilities, equipment and components.

5 Safety

This Clause does not list all the safety requirements for testing. Users of this Standard shall establish safety guidelines before testing.

The safety requirements in the testing process include at least the following elements:

- Before the implementation of the test, the various hazards that may harm the test personnel during the test process shall be identified; and the test personnel shall be trained and necessary protective measures shall be taken;
- Test personnel shall comply with the safety requirements of the testing site, wear protective work clothes and relevant protective equipment according to the requirements of the testing site;
- When operating in a closed workshop, the oxygen content and other corresponding factors shall be considered, and necessary protective measures shall be taken;
- When operating at high altitude, factors such as falling of personnel and testing equipment and instrument shall be considered; and necessary protective measures should be taken;
- When operating in harsh environments like at low and high temperature, etc., factors such as frostbite, scald, and heat stroke shall be considered; and necessary protective measures shall be taken;
- During the operation of the instrument, pay attention to the high-voltage leakage inspection of the instrument itself and the wires to avoid high-voltage discharge causing harm to the human body or objects.

Integrated non-destructive testing equipment is a combination BETWEEN subsystems that implement multiple non-destructive testing methods AND multiple auxiliary systems, including integrated non-destructive testing instruments, one or more testing sensors, signal transmission and processing systems (for testing system with distributed testing structures), mechanical scanning equipment and storage/power supply equipment, etc.

8.2 Integrated non-destructive testing instrument

The integrated non-destructive testing instrument shall have the testing functions of two or more non-destructive testing methods; and its functions and technical indicators shall be adaptive to the testing objects and testing purposes.

The integrated non-destructive testing instrument shall have the function of coordination and comprehensive processing of the testing process of two or more non-destructive testing methods; and should have an instrument operation control subsystem, a database subsystem, etc., to achieve non-destructive testing, data processing, data transmission and data storage management and other functions.

The testing instruments of the networked integrated nondestructive testing system shall also have network subsystems and servers to centrally manage the distributed testing subsystems, so that different subsystems can coordinate actions and achieve the overall system performance.

Appropriate technical means shall be adopted to inspect the functions and performance technical indicators of the integrated non-destructive testing instrument.

8.3 Testing sensor

The appropriate integrated testing sensor or sensor combination shall be selected according to the testing purpose and integrated non-destructive testing instrument.

The testing sensor shall be installed and used correctly according to the testing environment.

Appropriate technical means shall be adopted to inspect the function and performance technical indicators of the testing sensor.

8.4 Signal transmission and processing system

For the non-destructive testing networked integrated system with distributed testing structure, the signal transmission and processing system shall effectively transform and integrate different types of data distributed in different locations to realize the information sharing between the various subsystems.

The signal transmission and processing system shall follow the principles of reliability, effectiveness, and economy, and be selected according to the testing environment and

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