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Nondestructive testing of pressure equipment - Part 1: General requirements

承压设备无损检测 第 1 部分：通用要求

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Table of Contents

Nondestructive testing of pressure equipment – Part 1: General requirements

1 Scope

This Part of NB/T 47013 specifies the general requirements and use principles of radiographic testing, ultrasonic testing, magnetic particle testing, penetrant testing, eddy current testing, leak testing, visual testing, acoustic emission testing, ultrasonic time of flight diffraction technique testing, X-ray digital radiography testing, magnetic flux leakage testing, pulsed eddy current testing and other nondestructive testing methods.

This Part applies to the nondestructive testing of pressure equipment manufactured by metal materials, both in processing and in use.

2 Normative references

The following documents are necessary to the application of this document. For all dated references, only the dated edition applies to this document. for all undated references, the latest edition (including all amendments) applies.

GB/T 12604 (all parts) Non-destructive testing -Terminology

GB/T 20737 Non-destructive testing - General terms and definitions

NB/T 47013.2 Nondestructive testing of pressure equipment - Part 2: Radiographic testing

NB/T 47013.3 Nondestructive testing of pressure equipment - Part 3: Ultrasonic testing

NB/T 47013.4 Nondestructive testing of pressure equipment - Part 4: Magnetic particle testing

NB/T 47013.5 Nondestructive testing of pressure equipment - Part 5: Penetrant testing

NB/T 47013.6 Nondestructive testing of pressure equipment - Part 6: Eddy current testing

NB/T 47013.7 Nondestructive testing of pressure equipment - Part 7: Visual testing

b) The interlayers are lack of fusion;

c) The root is lack of fusion.

3.4

Slag

The residual slag in weld metals. According to the formation situation, the slag may be:

a) Linear;

b) Isolated;

c) Clustered.

3.5

Burn-through

The perforation formed because molten metal flows from the back of groove in welding process.

3.6

Overlap

The metal overlap formed because the molten metal flows to unmelted base metal or welding line in welding process.

3.7

Undercut

The irregular gap produced for the welding at weld toe of base metal (or the pre-deposited metal).

3.8

Porosity

The hole formed because the gas could not escape and left when the molten metal is in solidification.

3.9

Crack

The gap produced by the new interface formed because the combination of metal

The ratio of defects to total defects that can be tested by skilled nondestructive testing personnel according to given equipment and process documents on workpieces under given environmental conditions.

4 General requirements

4.1 Testing personnel

4.1.1 Personnel conducting nondestructive testing of pressure equipment shall obtain corresponding nondestructive testing personnel qualifications according to relevant provisions about the review to nondestructive testing personnel of national special equipment.

4.1.2 The qualification of nondestructive testing personnel is divided into class I (primary), class II (intermediate) and class III (advanced).

4.1.3 Personnel acquiring different qualification classes of different nondestructive testing methods can only be engaged in nondestructive testing work corresponding to the method and the qualification.

4.2 Testing equipment and devices

4.2.1 Testing equipment and main devices shall be accompanied with product quality certification documents.

4.2.2 Testing equipment and devices shall comply with provisions of corresponding product standard and the performances of them shall meet relevant requirements specified in the Standard NB/T 47013.2 ~ 47013.13 and certification documents are required to provide.

4.2.3 For nondestructive testing equipment and devices related to sensitivity used repeatedly, to ensure that their work performances comply with relevant requirements of each part of the Standard continuously, the organization undertaking the nondestructive testing (i.e. testing organization or testing department of enterprises, hereinafter referred to as the testing organization) shall conduct checking, calibration or verification regularly (each year or a longer period, according to relevant requirements of each part of the Standard) and shall specify them in the process rules of the testing organization:

a) Checking: all nondestructive testing equipment and devices related to sensitivity listed in the national compulsory verification catalog that shall be conducted with compulsory testing management shall be sent to qualified legal metrological verification or authorized metrology institutes for checking;

b) Calibration: regular calibration shall be done to nondestructive testing equipment

documents. According to provisions of this Standard and provisions of NB/T 47013.2 ~ 47013.13, it shall select one or more appropriate nondestructive testing methods, determine the testing technology class, testing rate, qualify requirements, qualified level and others to form specific testing requirements.

4.3.1.4 When nondestructive testing methods not listed in the provisions of this Standard or exceeding the applicable scope of this Standard, corresponding nondestructive testing personnel, equipment and devices and testing process documents shall be equipped and enterprise standard shall be formed after field test and technical identification and the enterprise standard shall comply with provisions of relevant laws and regulations and procedures in actual application.

4.3.2 Process documents of nondestructive testing

4.3.2.1 The testing organization shall develop process documents of nondestructive testing, which shall include process procedure and operating instruction.

4.3.2.2 It shall develop process procedure according to relevant laws and regulations, product standards and requirements of relevant technical documents and this Standard and aiming to the characteristics and technical conditions of the testing organization; special scope or requirements of relevant factors in the process procedure shall be defined according to provisions of this Part and NB/T 47013.2 ~ 47013.13. The process procedure shall be redeveloped or revised if the change of relevant factors exceeds provisions.

4.3.2.3 It shall develop operating instruction according to process procedure and specific testing requirements of testing object; the content of the operating instruction shall be complete, clear and concrete; process verification shall be done to the operating instruction in the first application and the verification can adopt reference block, stimulation block or can be done on the testing object directly.

4.3.2.4 The content of process document of nondestructive testing shall comply with relevant requirements of this Part and NB/T 47011.2 ~ 47013.13.

4.4 Testing place and environment

4.4.1 The testing place and environment includes but not limited to energy, lighting and environmental conditions (including wind speed, temperature, humidity and other factors), which shall contribute to the effective implementation of nondestructive testing.

4.4.2 In addition to complying with national and local regulations on environmental health and labor protection, the testing place and environment shall not be place and environment with relative influence on human body that may interfere with normal operation, observe and judgment.

4.4.3 If the testing place and environment have effects on testing quality, shall adopt

particle testing is mainly used to ferromagnetic materials and the eddy current testing is mainly used to conducting metal materials.

5.1.4 Nondestructive testing methods that can test defects on any part of materials include radiographic testing, ultrasonic testing, ultrasonic time of flight diffraction technique testing and X-ray digital radioscopic examination. Generally speaking, the testing capability of ultrasonic testing, ultrasonic time of flight diffraction technique testing to surface opening defects or near surface defects is lower than that of magnetic particle testing, penetrant testing or eddy current testing.

5.1.5 To determine the strength and general location of active defects in the pressure equipment or on the pressure equipment, can use acoustic emission testing. Applied voltage test shall be done to pressure equipment in acoustic emission testing and shall use other nondestructive methods to conduct retesting when finding active defects.

5.1.6 Nondestructive testing method that can only detect penetrability defects or overall density of pressure equipment is leak testing.

5.1.7 For ferro magnetic materials, magnetic particle testing is preferable to use to test surface or near surface defects. When magnetic particle testing can not be used for structure and shape, can use other nondestructive methods.

5.1.8 When one nondestructive testing method is used according to different testing process, if the testing results are inconsistent, the result shall be subject to the one with larger risk in rating scale.

5.1.9 When two or more testing methods are used to test the same part of the pressure equipment, shall decide the rating scale according to method of each testing method.

5.2 Capability scope and limitations of each nondestructive testing method

5.2.1 Radiographic testing

5.2.1.1 Capability scope:

a) It can test incomplete penetration, porosity, slag, crack, lack of fusion of groove and other defects in welded joints;

b) It can test shrinkage, inclusion, porosity, loosen and other defects in castings;

c) It can determine the location and size of planar projection of defects and the nature of defects;

d) The penetrate ability in radiographic testing is mainly determined by ray energy.

5.2.1.2 Limitations:

5.2.3.1 Capability scope:

It can test surface opening defects and near surface defects in ferro magnetic materials.

5.2.3.2 Limitations:

a) It is difficult to defect workpieces with complex geometric construction;

b) It is difficult to defect workpieces in non-ferromagnetic materials.

5.2.3.3 The specific requirements of magnetic particle testing shall be conducted according to provisions of NB/T 47013.4.

5.2.4 Penetrant testing

5.2.4.1 Capability scope:

It can test surface opening defects in metal materials, such as porosity, slag, crack, loosen and other defects.

5.2.4.2 Limitations:

It is difficult to test porous materials.

5.2.4.3 The specific requirements of penetrant testing shall be conducted according to provisions of NB/T 47013.5.

5.2.5 Eddy current testing

5.2.5.1 Capability scope:

a) It can test defects on the surface and near surface of butt joints of metal materials and base metal;

b) It can test defects on the surface and near surface of metal materials with non-metallic coating;

c) It can determine the location of defect and give the reference values of the depth of surface opening defects or near surface defects;

d) The sensitivity and testing depth of eddy current testing are mainly determined by the excitation energy and frequency of eddy current.

5.2.5.2 Limitations:

a) It is difficult to test defects buried in metal materials;

b) It is difficult to test defects on surface and near surface of metal materials with

b) The difference between inner pressure and external pressure of buried pipelines have great effects on the determination of leaking test location and leak rate.

5.2.7.3 The specific requirements of leak testing shall be conducted according to provisions of NB/T 47013.8.

5.2.8 Acoustic emission testing

5.2.8.1 Capability scope:

a) It can test the location, activity and strength of cracks and other active defects of pressure equipment manufactured by metal materials during pressure test;

b) It can test and evaluate the distribution and state of defects in the overall structure generally during one times of pressure test;

c) It can test real-time and continuous information of the change of active defects with the change of load and others.

5.2.8.2 Limitations:

a) It is difficult to test non-active defects;

b) It is difficult to make the tested active defects be qualitative and quantitative and we still need other nondestructive testing methods for reexamination;

c) It is sensitive to materials and is susceptible to mechanical and electrical noise interference and the accurate interpretation of date of it require more extensive database and field testing experience.

5.2.8.3 The specific requirements of acoustic emission testing shall be conducted according to provisions of NB/T 47013.9.

5.2.9 Ultrasonic time of flight diffraction technique testing

5.2.9.1 Capability scope:

a) It can test incomplete penetration, porosity, slag, crack, lack of fusion and other defects and the probability of detection is high;

b) It can determine the depth, length and height of defects;

c) The defection sensitivity of defects of workpiece with thick wall is high;

d) The testing result is intuitive and the test date can be recorded and stored.

5.2.9.2 Limitations:

5.2.10.3 The specific requirements of X-ray digital radioscopic examination shall be conducted according to provisions of NB/T 47013.11.

5.2.11 Magnetic flux leakage testing

5.2.11.1 Capability scope:

a) It can test corrosion, mechanical damages and volume defects such as thickness reduction on the surface of base metal of ferromagnetic material with coatings;

b) It can test cracks and other planar defects on the surface of base metal of ferromagnetic material with coatings;

c) It can test the location of defects and can measure the length of surface opening defect or volume defects;

d) The sensitivity and testing depth of magnetic flux leakage testing are mainly decided by the excitation depth and the sensor resolution.

5.2.11.2 Limitations:

a) It is difficult to test defects buried in ferromagnetic materials;

b) It is difficult to test defects of workpiece with thickness exceeding 30 mm;

c) It is difficult to test defect parallel to the excitation direction;

d) It is difficult to test welding defects.

5.2.11.3 The specific requirements of magnetic flux leakage testing shall be conducted according to provisions of NB/T 47013.12.

5.2.12 Pulsed eddy current testing

5.2.12.1 Capability scope:

a) It can test corrosion of metal wall under non-ferromagnetic covering layer (insulation, cold layer, protective layer, etc.) or other thickness reduction defects;

b) It can test equipment when equipment are in running state (high temperature, low temperature and there are materials inside, etc.);

c) The testing result is the mean remaining thickness under the projected area of sensor.

5.2.12.2 Limitations:

a) It is difficult to test defects with small volume;

6.3.3 It shall consider the falling of personnel, testing equipment and devices and other factors and take necessary protection measure when operating at high altitude.

6.3.4 It shall consider cold injury, heat stroke and other factors and take necessary protection measures when operating in extreme environment, such as copious cooling, high temperature and so on.

6.3.5 If there are toxic gases and various environmental factors that may harm human body, shall carefully identify them and take necessary protection measures in conducting nondestructive testing.

7 Data and archive of nondestructive testing

7.1 Archive of nondestructive testing

The testing organization shall establish complete archive of nondestructive testing, which shall include the following contents at least:

a) Nondestructive testing order ticket or inspection and testing contract;

b) Nondestructive testing process documents;

c) Nondestructive testing records;

d) Nondestructive testing report.

7.2 Nondestructive testing process documents

7.2.1 Nondestructive testing process documents include process procedure and operation instruction.

7.2.2 Process procedure shall at least include the following contents:

a) Version number of process procedure;

b) Applicable scope;

c) Standards, laws and regulations and other technical documents used as basis;

d) Qualification requirements to testing personnel;

e) Testing equipment and devices, requirements of checking, calibration or verification and items, cycle and performance indicators of checking implementation;

f) Relevant factor items and scope involved in process procedure;

7.3 Nondestructive testing record

7.3.1 The nondestructive testing record shall at least include the following contents:

a) Record number;

b) Name and number of operating instruction used as basis;

c) Requirements of testing technology: enforced standard and qualified level;

d) Testing object: category of pressure equipment, name, number, specification size, material, heat treatment state, tested part and testing ratio of testing objects, surface state in testing and testing timing;

e) Testing equipment and devices: name, specification model and number;

f) Testing process parameters;

g) Testing schematic;

h) Original testing data;

i) Evaluation result of testing data;

j) Testing personnel;

k) Testing date and location.

7.3.2 The nondestructive testing record shall be true, accurate, complete and valid and shall be signed and recognized by appropriate responsible persons.

7.3.3 The storage life of nondestructive testing record shall comply with requirements of relevant regulations and standards and it shall not be less than 7 years. After 7 years, the original testing data can be transferred to the user for safekeeping if the user requires.

7.4 Nondestructive testing report

7.4.1 The nondestructive testing report shall at least include the following contents:

a) Report number;

b) Requirements of testing technology: enforced standard and qualified level;

c) Testing object: category of pressure equipment, name, number, specification size, material, heat treatment state, tested part and testing ratio of testing objects, surface state in testing and testing timing, etc.

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